

DRAFT

U.S. Atlantic and Gulf of Mexico
Marine Mammal
Stock Assessments - 2001

DRAFT

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EXECUTIVE SUMMARY

Under the 1994 amendments of the Marine Mammal Protection Act (MMPA), the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) were required to generate stock assessment reports (SAR) for all marine mammal stocks in waters within the U.S. Exclusive Economic Zone (EEZ). The first reports for the Atlantic (includes the Gulf of Mexico) were published in July 1995 (Blaylock *et al.* 1995). The MMPA requires NMFS and USFWS to review these reports annually for strategic stocks of marine mammals and at least every 3 years for stocks determined to be non-strategic. The second edition of the SARs (1996 assessments) was published in October 1997 and contained all the previous reports, but major revisions and updating were only completed for strategic stocks (Waring *et al.* 1997). Updated reports were identified by a 1997 date-stamp at the top right corner at the beginning of each report. The 3rd edition of the SARs (1998 assessments) only contained reports for Atlantic stocks, and updated reports were identified by a 1998 date-stamp (Waring *et al.* 1999). The 4th edition of the SARs (1999 assessments) only contained reports for Atlantic stocks, and updated reports were identified by a 1999 date-stamp (Waring *et al.* 1999). The 5th edition of the SARs contains all NMFS reports for the Atlantic (includes the Gulf of Mexico), and the USFWS West Indian manatee assessments. Updated reports were identified by a 2000 date-stamp (Waring *et al.* 2000). The current (2001) draft report contains only updated assessments for Atlantic strategic stocks, and for Atlantic and Gulf of Mexico stocks for which significant new information was available. These reports are identified by a December 2000 date-stamp at the beginning of each report.

This report was prepared by staff of the Northeast Fisheries Science Center (NEFSC), and Southeast Fisheries Science Center (SEFSC). NMFS staff presented the reports at the November 2000 meeting of the Atlantic Scientific Review Group (ASRG), and subsequent revisions were based on their contributions and constructive criticism.

Table 1 contains a summary, by species, of the information included in the stock assessments, and also indicates those that have been revised since the 2000 publication. A total of 17 of the 60 Atlantic and Gulf of Mexico stock assessment reports were revised for 2001. Most of the proposed changes incorporate new information into sections on population size and mortality estimates. The revised SARs include 12 strategic and 5 non-strategic stocks. Information on human interactions (fishery and ship strikes) between the right whale, humpback whale, fin whale and minke whale stocks were re-reviewed and updated. This is a working document and individual stock assessment reports will be updated as new information becomes available and as changes to marine mammal stocks and fisheries occur. The authors solicit any new information or comments which would improve future stock assessment reports.

INTRODUCTION

Section 117 of the 1994 amendments to the Marine Mammal Protection Act (MMPA) requires that an annual stock assessment report (SAR) for each stock of marine mammals that occurs in waters under U.S. jurisdiction, be prepared by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS), in consultation with regional Scientific Review Groups (SRG). The SRGs are a broad representation of marine mammal and fishery scientists and members of the commercial fishing industry mandated to review the marine mammal stock assessments and provide advice to the Assistant Administrator for NMFS. The reports are then made available on the *Federal Register* for public review and comment before final publication.

The MMPA requires that each SAR contain several items, including: (1) a description of the stock, including its geographic range; (2) a minimum population estimate, a maximum net productivity rate, and a description of current population trend, including a description of the information upon which these are based; (3) an estimate of the annual human-caused mortality and serious injury of the stock, and, for a strategic stock, other factors that may be causing a decline or impeding recovery of the stock, including effects on marine mammal habitat and prey; (4) a description of the commercial fisheries that interact with the stock, including the estimated number of vessels actively participating in the fishery and the level of incidental mortality and serious injury of the stock by each fishery on an annual basis; (5) a statement categorizing the stock as strategic or not, and why; and (6) an estimate of the potential biological removal (PBR) level for the stock, describing the information used to calculate it. The MMPA also requires that SARs be updated annually for stocks which are specified as strategic stocks, or for which significant new information is available, and once every three years for nonstrategic stocks.

Following enactment of the 1994 amendments, the NMFS and FWS held a series of workshops to develop guidelines for preparing the SARs. The first set of stock assessments for the Atlantic Coast (including the Gulf of Mexico) were published in July 1995 in the *NOAA Technical Memorandum* series (Blaylock *et al.* 1995). In April 1996, the NMFS held a workshop to review proposed additions and revisions to the guidelines for preparing SARs (Wade and Angliss 1997). Guidelines developed at the workshop were followed in preparing the 1996 (Waring *et al.* 1997), 1998 (Waring *et al.* 1999), 1999 (Waring *et al.* 1999), 2000 (Waring *et al.* 2000) SARs. A 1997 SAR was not produced.

In this document, major revisions and updating of the SARs were only completed for Atlantic Coast strategic stocks and Atlantic Coast stocks for which significant new information were available. These are identified by the December 2000 date-stamp at the top right corner at the beginning of each report.

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TABLE 1. A SUMMARY(including footnotes) OF ATLANTIC MARINE MAMMAL STOCK ASSESSMENT REPORTS FOR STOCKS OF MARINE MAMMALS UNDER NMFS AUTHORITY THAT OCCUPY WATERS UNDER USA JURISDICTION. The “SAR revised” column indicates 2000¹ stock assessment reports that have been revised relative to the 1999²⁰⁰⁰ reports (Y=yes N=no). If abundance, mortality or PBR estimates have been revised, they are indicated with the letters “a”, “m” and “p” respectively.

Species	Stock Area	SRG Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mort.	Annual Fish. Mort.	Strategic Status	SAR Revised
Harbor seal	Western North Atlantic	ATL	NEC	30,990	0.12	1.0	1,859	873 895	873 895	N	Y m
Gray seal	Western North Atlantic	ATL	NEC	NA	NA	NA	NA	75 103	75 103	N	Y m
Harp seal	Western North Atlantic	ATL	NEC	N/A	N/A	N/A	N/A	402 245	402 245	N	Y m
Hooded seal	Western North Atlantic	ATL	NEC	N/A	N/A	N/A	N/A	5.6	5.6	N	N
Harbor porpoise	Gulf of Maine/Bay of Fundy	ATL	NEC	48,289 74,695	0.04	0.5	483 747	1,578 382 ¹	1,521 381 ¹	Y	Y a,m,p
Risso's dolphin	Western North Atlantic	ATL	NEC	22,916	0.04	0.48	220	52 56	52 56	N	Y m
Atlantic white-sided dolphin	Western North Atlantic	ATL	NEC	19,196 37,904	0.04	0.48	184 364	223 136	223 136	Y	Y a,m,p
White-beaked dolphin	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	0.00	0.00	N	N
Common dolphin	Western North Atlantic	ATL	NEC	23,655	0.04	0.48	227	612 406	612 406	Y	Y m
Atlantic spotted dolphin	Western North Atlantic	ATL	NEC	27,785 ³	0.04	0.5	278	7.8 ²	7.8 ²	N	Y N
Pantropical spotted dolphin	Western North Atlantic	ATL	NEC	8,450	0.04	0.5	84	7.8 ²	7.8 ²	N	Y N
Striped dolphin	Western North Atlantic	ATL	NEC	44,500	0.04	0.5	445	7.3	7.3	N	Y N
Spinner dolphin	Western North Atlantic	ATL	NEC	N/A	N/A	N/A	N/A	0.31	0.31	N	N

Species	Stock Area	SRG Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mort.	Annual Fish. Mort.	Strategic Status	SAR Revised
Bottlenose dolphin	Western North Atlantic, offshore	ATL	SEC	24,897 ³	0.04	0.5	249	5.3	5.3	N	Y N
Bottlenose dolphin	Western North Atlantic, coastal	ATL	SEC	2,482	0.04	0.5	25	46	46	Y	Y N
Dwarf sperm whale	Western North Atlantic	ATL	SEC	373 ⁴	0.04	0.5	3.7	0.25	0.25	N	Y N
Pygmy sperm whale	Western North Atlantic	ATL	SEC	373 ⁴	0.04	0.5	3.7	0.25	0.25	N	Y N
Killer whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	0.00	0.00	N	N
Pygmy killer whale	Western North Atlantic	ATL	SEC	6	0.04	0.5	0.1	0.00	0.00	N	N
Northern bottlenose whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	0.00	0.00	N	N
Cuvier's beaked whale	Western North Atlantic	ATL	NEC	2,419 ⁵	0.04	0.5	24	9.5 0	9.5 ⁶ 0	Y	Y m
Mesoplodon beaked whale	Western North Atlantic	ATL	NEC	2,419 ⁵	0.04	0.5	24	9.5 0	9.5 ⁶ 0	Y	Y m
Pilot whale, long-finned	Western North Atlantic	ATL	NEC	11,343 ⁷	0.04	0.5 0.48	113 108	146 ⁸ 245	137 245 ⁸	Y	Y m, p
Pilot whale, short-finned	Western North Atlantic	ATL	SEC	11,343 ⁷	0.04	0.5 0.48	113 108	146 ⁸ 245	137 245 ⁸	Y	Y m, p
Sperm whale	North Atlantic	ATL	NEC	3,505	0.04	0.1	7.0	0.00	0.00	Y	Y a,p
North Atlantic right whale	Western North Atlantic	ATL	NEC	291	0	0.1	0.0	1.4 2.2 ⁹	0.6 1.0 ⁹	Y	N Y m
Humpback whale	Western North Atlantic Gulf of Maine	ATL	NEC	10,019 568	0.065	0.1	33 1.8	3.7 4.2 ¹⁰	2.7 3.2 ¹⁰	Y	Y a,m,p

Species	Stock Area	SRG Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mort.	Annual Fish. Mort.	Strategic Status	SAR Revised
Fin whale	Western North Atlantic	ATL	NEC	1,803 2,362	0.04	0.1	3.6 4.7	0.8 1.8 ¹¹	0.20.6 ¹¹	Y	Y a,m,p
Sei whale	Nova Scotia	ATL	NEC	N/A	0.04	0.1	N/A	0.00	0.00	Y	Y N
Minke whale	Canadian east coast	ATL	NEC	3,097 3,515	0.04	0.5	31 35	3.0 2.4 ¹²	3.02.2 ¹²	N	Y a, m, p
Blue whale	Western North Atlantic	ATL	NEC	308	0.04	0.1	0.6	0.00	0.00	Y	Y
Bottlenose dolphin	Gulf of Mexico bay, sound, and estuarine	ATL	SEC	3,933	0.04	0.5	39	N/A	N/A	Y	Y N
Dwarf sperm whale	Northern Gulf of Mexico	ATL	SEC	N/A	0.04	N/A	N/A	0.00	0.00	N	Y N
Pygmy sperm whale	Northern Gulf of Mexico	ATL	SEC	N/A	0.04	N/A	N/A	0.00	0.00	N	Y N

1. ~~Total mortality includes 57 harbor porpoises from the Canadian sink gillnet and herring weir fisheries.~~ The total annual estimated average human-caused mortality is 382 harbor porpoises per year. This is derived from four components: 323 harbor porpoise per year (CV=0.25) from USA fisheries using observer data, 39 per year (unknown CV) from Canadian fisheries using observer data, 19 per year from USA unknown fisheries using strandings data, and 1 per year from unknown human-caused mortality (a mutilated stranded harbor porpoise)
2. Mortality data are not separated by species; therefore, species-specific estimates are not available. The mortality estimate represents both Atlantic and Pantropical spotted dolphins
3. Estimates may include sightings of the coastal form.
4. This estimate may include both the dwarf and pygmy sperm whales.
5. This estimate includes Cuvier's beaked whales and undifferentiated *Mesoplodon* spp. beaked whales.
6. This is the average mortality of undifferentiated beaked whales (*Mesoplodon* spp.) based on 5 years of observer data. This annual mortality rate includes an unknown number of Cuvier's beaked whales.
7. This estimate may include both long-finned and short-finned pilot whales.
8. Mortality data are not separated by species; therefore, species-specific estimates are not available. This mortality estimate represents both long-finned and short-finned pilot whales. Total annual mortality includes Nova Scotia 9594-96 average of 98 long-finned pilot whales.
9. ~~This is the average mortality of right whales based on 5 years of observer data (0.0) and additional fishery impact records (0.6).~~ The total estimated human-caused mortality and serious injury to right whales is estimated at 2.2 per year (USA waters, 1.4; Canadian waters, 0.8). This is derived from two components: 1) non-observed fishery entanglement records at 1.0 per year (USA waters, 0.6 ; Canadian waters, 0.4), and 2) ship strike records at 1.2 per year (USA waters, 0.8 ; Canadian waters, 0.4).
10. ~~This is the average mortality of humpback whales based on 5 years of observer data (0.25) and additional fishery impact records (2.4).~~ The total estimated human-caused mortality and serious injury to the Gulf of Maine humpback whale stock is estimated as 4.2 per year (USA waters, 3.8; Canadian waters, 0.4). This

- average is derived from two components: 1) incidental fishery interaction records 3.2 (USA waters, 2.8; Canadian waters, 0.4); and 2) records of vessel collisions , 1.0 (USA waters, 1.0; Canadian waters, 0).
11. This is based on a review of NMFS anecdotal records from 1994~~5~~-1998~~9~~, that yielded an average of ~~0.8~~1.8 human caused mortality ~~-0.6~~1.2 ship strikes (all US waters), ~~0.2~~0.6 fishery interactions (0.4 US waters, 0.2 Canadian waters).
 12. During 1995 to 1998, the USA total annual estimated average human-caused mortality is ~~2.4~~3.0 minke whales per year. This is derived from three components: ~~0.1~~1 minke whales per year (CV=0.0) from USA observed fisheries using observer data, ~~2.2~~1.6 minke whales per year from USA fisheries using strandings and entanglement data, and ~~0.2~~3 minke whales per year from ship strikes.

NORTH ATLANTIC RIGHT WHALE (*Eubalaena glacialis*): Western Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Individuals of the western North Atlantic right whale population range from wintering and calving grounds in coastal waters of the southeastern United States to summer feeding and nursery grounds in New England waters and northward to the Bay of Fundy and the Scotian Shelf. Knowlton *et al.* (1992) reported several long-distance movements as far north as Newfoundland, the Labrador Basin, and southeast of Greenland; in addition, recent resightings of photographically identified individuals have been made off Iceland and arctic Norway. The latter (in September 1999) represents one of only two sightings this century of a right whale in Norwegian waters, and the first since 1926. Together, these long-range matches indicate an extended range for at least some individuals and perhaps the existence of important habitat areas not presently well described. Similarly, records from the Gulf of Mexico (Moore and Clark 1963; Schmidly *et al.* 1972) represent either geographic anomalies or a more extensive historic range beyond the sole known calving and wintering ground in the waters of the southeastern United States. Whatever the case, the location of a large segment of the population is unknown during the winter. Offshore surveys flown off the coast of northeastern Florida and southeastern Georgia from 1996 to 2000 had three sightings in 1996, one in 1997, thirteen in 1998, six in 1999, and eleven in 2000 (within each year, some were repeat sightings of previously recorded individuals). The frequency with which right whales occur in offshore waters in the southeastern U.S. remains unclear.

Research results to date suggest the existence of six major habitats or congregation areas for western North Atlantic right whales; these are the coastal waters of the southeastern United States, the Great South Channel, Georges Bank/Gulf of Maine, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Scotian Shelf. However, movements within and between habitats may be more extensive than is sometimes thought. Results from a few successfully attached satellite tags clearly indicate that sightings separated by perhaps two weeks should not necessarily be assumed to indicate a stationary or resident animal. Instead, telemetry data have shown rather lengthy and somewhat distant excursions, including into deep water off the continental shelf (Mate *et al.* 1997). These findings indicate that movements and habitat use are more complex than previously thought.

New England waters are a primary feeding habitat for the right whale, which appears to feed primarily on copepods (largely of the genera *Calanus* and *Pseudocalanus*) in this area. Research suggests that right whales must locate and exploit extremely dense patches of zooplankton to feed efficiently (Mayo and Marx 1990). These dense zooplankton patches are likely a primary characteristic of the spring, summer, and fall right whale habitats (Kenney *et al.* 1986, 1995). Acceptable surface copepod resources are limited to perhaps 3% of the region during the peak feeding season in Cape Cod and Massachusetts Bays (C. Mayo pers. comm.). While feeding in the coastal waters off Massachusetts has been better studied than in most areas, feeding by right whales has been observed elsewhere on the margins of Georges Bank, in the Gulf of Maine, in the Bay of Fundy, and over the Scotian Shelf. The characteristics of acceptable prey distribution in these areas are not well known. In addition, New England waters serve as a nursery for calves and perhaps also as a mating ground. NMFS and Center for Coastal Studies aerial surveys in the spring of 1999 and 2000 found substantial numbers of right whales along the Northern Edge of Georges Bank, in Georges Basin, and in various locations in the Gulf of Maine; the latter include Cashes Ledge, Platts Bank and Wilkinson Basin. The predictability with which right whales occur in such locations remains unclear, and these new data highlight the need for more extensive surveys of habitats which have previously received minimal coverage.

Recent genetic analyses based upon direct sequencing of mitochondrial DNA (mtDNA) have identified five mtDNA haplotypes in the western North Atlantic population (Malik *et al.* 1999). Schaeff *et al.* (1997) compared the genetic variability of North Atlantic and southern right whales (*E. australis*), and found the former to be significantly less diverse, a finding broadly replicated from sequence data by Malik *et al.* (2000). These findings might be indicative of inbreeding in the population, but no definitive conclusion can be reached using current data. Additional work comparing modern and historic genetic population structure in right whales, using DNA extracted from museum and archaeological specimens of baleen and bone, is also underway (Rosenbaum *et al.* 1997, 2000). Preliminary results suggest that the eastern and western North Atlantic populations were not genetically distinct (Rosenbaum *et al.* 2000). However, the virtual extirpation of the eastern stock and its lack of recovery in the last hundred years strongly

suggests population subdivision over a protracted (but not evolutionary) timescale. Results also suggest that, as expected, the principal loss of genetic diversity occurred during major exploitation events prior to the 20th century.

To date, skin biopsy sampling has resulted in the compilation of a DNA library of more than 280 North Atlantic right whales. When work is completed, a genetic profile will be established for each individual, and an assessment provided on the level of genetic variation in the population, the number of reproductively active individuals, reproductive fitness, the basis for associations and social units in each habitat area, and the mating system. Tissue analysis has also aided in sex identification: the sex ratio of the photo-identified and catalogued population does not differ significantly from parity (M.W. Brown, pers. comm.). Analyses based on both genetics and sighting histories of photographically identified individuals also suggest that approximately one-third of the population utilizes summer nursery grounds other than the Bay of Fundy. As described above, a related question is where individuals other than calving females and a few juveniles overwinter. One or more additional wintering and summering grounds may exist in unsurveyed locations, although it is also possible that “missing” animals simply disperse over a wide area at these times. Identification of such areas, and the possible threats to right whales there, is recognized as a priority for research efforts.

POPULATION SIZE

Based on a census of individual whales identified using photo-identification techniques, the western North Atlantic population size was estimated to be 295 individuals in 1992 (Knowlton *et al.* 1994); an updated analysis using the same method gave an estimate of 291 animals in 1998 (Kraus *et al.* 2000). Because this was a nearly complete census, it is assumed that this represents a minimum population size estimate. However, no estimate of abundance with an associated coefficient of variation has been calculated for this population. Calculation of a reliable point estimate is likely to be difficult given the known problem of heterogeneity of distribution in this population. An IWC workshop on status and trends of western North Atlantic right whales gave a minimum direct-count estimate of 263 right whales alive in 1996 and noted that the true population was unlikely to be substantially greater than this (IWC 2000).

Historical Abundance

An estimate of pre-exploitation population size is not available. Basque whalers may have taken substantial numbers of right whales at times during the 1500s in the Strait of Belle Isle region (Aguilar 1986), and the stock of right whales may have already been substantially reduced by the time whaling was begun by colonists in the Plymouth area in the 1600s (Reeves and Mitchell 1987). A modest but persistent whaling effort along the coast of the eastern USA lasted three centuries, and the records include one report of 29 whales killed in Cape Cod Bay in a single day during January 1700. Based on incomplete historical whaling data, Reeves and Mitchell (1987) could conclude only that there were at least some hundreds of right whales present in the western North Atlantic during the late 1600s. In a later study (Reeves *et al.* 1992), a series of population trajectories using historical data and an estimated present population size of 350 were plotted. The results suggest that there may have been at least 1,000 right whales in this population during the early to mid-1600s, with the greatest population decline occurring in the early 1700s. The authors cautioned, however, that the record of removals is incomplete, the results were preliminary, and refinements are required. Based on back calculations using the present population size and growth rate, the population may have numbered fewer than 100 individuals by the time that international protection for right whales came into effect in 1935 (Hain 1975; Reeves *et al.* 1992; Kenney *et al.* 1995). However, too little is known about the population dynamics of right whales in the intervening years to state anything with confidence.

Minimum Population Estimate

The western North Atlantic population size was estimated to be 291 individuals in 1998 (Kraus *et al.* 2000), based on a census of individual whales identified using photo-identification techniques. A bias that might result from including catalogued whales that had not been seen for an extended period of time and therefore might be dead, was addressed by assuming that an individual whale not sighted for five or more years was dead (Knowlton *et al.* 1994). It is assumed that the census of identified and presumed living whales represents a minimum population size estimate. The true population size in 1998 may have been higher if: 1) there were animals not photographed and identified, and/or 2) some animals presumed dead were not.

Current Population Trend

The population growth rate reported for the period 1986-92 by Knowlton *et al.* (1994) was 2.5% (CV=0.12); this suggested that the stock was showing signs of slow recovery. However, work by Caswell *et al.* (1999) has suggested that crude survival probability declined from about 0.99 in the early 1980's to about 0.94 in the late 1990's. The decline was statistically significant. Additional work conducted in 1999 was reviewed by the IWC workshop on status and trends in this population (IWC 2000); the workshop concluded based on several analytical approaches that survival had indeed declined in the 1990's. Although heterogeneity of capture could negatively bias survival estimates, the workshop concluded that this factor could not account for all of the observed decline, which appeared to be particularly marked in adult females.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

During 1980-1992, 145 calves were born to 65 identified cows. The number of calves born annually ranged from 5 to 17, with a mean of 11.2 (SE = 0.90). The reproductively active female pool was static at approximately 51 individuals during 1987-1992. Mean calving interval, based on 86 records, was 3.67 years. There was an indication that calving intervals may be increasing over time, although the trend was not statistically significant ($P = 0.083$) (Knowlton *et al.* 1994).

Since that report, total reported calf production in 92/93 was 6; 93/94, 9; 94/95, 7; 95/96, 21; 96/97, 20; 97/98, 6; and 98/99, 4. The total calf production was reduced by reported calf mortalities: 2 mortalities in 1993, 3 in 1996, 1 in 1997, and 1 in 1998. Of the three calf mortalities in 1996, available data suggested one was not included in the reported 20 mother/calf pairs, resulting in a total of 21 calves born. Eleven of the 21 mothers in 1996 were observed with calves for the first time (*i.e.*, were "new" mothers) that year. Three of these were at least 10 years old, two were 9 years old, and six were of unknown age. An updated analysis of calving interval through the 1997/98 season suggests that mean calving interval increased since 1992 from 3.67 years to more than 5 years, a significant trend (Kraus *et al.* 2000). This conclusion is supported by modeling work reviewed by the IWC workshop on status and trends in this population (IWC 2000); the workshop agreed that calving intervals had indeed increased and further that the reproductive rate was approximately half that reported from studied populations of *E. australis*. The low calf production in subsequent years (4 in 1999 and only 1 in 2000, with the year incomplete) gives added cause for concern. A workshop on possible causes of reproductive failure was held in April 2000 (Reeves 2000); factors considered included contaminants, biotoxins, nutrition/food limitation, disease and inbreeding problems. While no conclusions were reached, a research plan to further investigate this topic was developed.

The annual population growth rate during 1986-1992 was estimated to be 2.5% (CV=0.12) using photo-identification techniques (Knowlton *et al.* 1994). A population increase rate of 3.8% was estimated from the annual increase in aerial sighting rates in the Great South Channel, 1979-1989 (Kenney *et al.* 1995). However, as noted above, more recent work has indicated that the population is now in decline (Caswell *et al.* 1999, IWC 2000).

An analysis of the age structure of this population suggests that it contains a smaller proportion of juvenile whales than expected (Hamilton *et al.* 1998, IWC 2000), which may reflect lowered recruitment and/or high juvenile mortality. In addition, it is possible that the apparently low reproductive rate is due in part to unstable age structure or to reproductive senescence on the part of some females. However, data on either factor are poor; senescence has been demonstrated in relatively few mammals (including humans, pilot whales and killer whales) and is currently undocumented for any baleen whale.

The relatively low population size indicates that this stock is well below its optimum sustainable population size (OSP); therefore, the current population growth rate should reflect the maximum net productivity rate for this stock. The population growth rate reported by Knowlton *et al.* (1994) of 2.5% (CV=0.12) was assumed to reflect the maximum net productivity rate for this stock for purposes of previous assessments. However, review by the IWC workshop of modeling and other work indicates that the population is now in decline; consequently, no growth rate can be used for western North Atlantic right whales.

POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal (PBR) is specified as the product of minimum population size, one-half the maximum net productivity rate and a "recovery" factor for endangered, depleted, threatened stocks, or stocks of unknown status relative to OSP (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The recovery factor for

right whales is 0.10 because this species is listed as endangered under the Endangered Species Act (ESA). However, in view of the decline in this population (Caswell *et al.* 1999, IWC 2000), the PBR for this population is set to zero.

ANNUAL HUMAN-CAUSED SERIOUS INJURY AND MORTALITY

For the period 1995 through 1999, the total estimated human-caused mortality and serious injury to right whales is estimated at 2.2 per year (USA waters, 1.4; Canadian waters, 0.8). This is derived from two components: 1) non-observed fishery entanglement records at 1.0 per year (USA waters, 0.6 ; Canadian waters, 0.4), and 2) ship strike records at 1.2 per year (USA waters, 0.8 ; Canadian waters, 0.4). Note that in the 1996 and 1998 stock assessment reports, a six-year time frame was used to calculate these averages. A five-year period has been used since to be consistent with the time frames used for calculating the averages for other species. It is also important to stress that serious injury determinations are made based upon the best available information; these determinations may change with the availability of new information. For the purposes of this report, discussion is primarily limited to those records considered confirmed human-caused mortalities or serious injuries.

Background

Approximately one-third of all right whale mortality is caused by human activities (Kraus 1990). The details of a particular mortality or serious injury record often require a degree of interpretation. The assigned cause is based on the best judgement of the available data; additional information may result in revisions. When reviewing Table 1 below, several factors should be considered: 1) a ship strike or entanglement may occur at some distance from the reported location; 2) the mortality or injury may involve multiple factors; for example, whales that have been both ship struck and entangled are not uncommon; 3) the actual vessel or gear type/source is often uncertain; and 4) in entanglements, several types of gear may be involved.

The serious injury determinations are most susceptible to revision. There are several records where a struck and injured whale was re-sighted later, apparently healthy, or an entangled or partially disentangled whale was re-sighted later free of gear. The reverse may also be true: a whale initially appearing in good condition after being struck or entangled is later re-sighted and found to have been seriously injured by the event. Entanglements of juvenile whales are typically considered serious injuries because the constriction on the animal is likely to become increasingly harmful as the whale grows.

We have limited the serious injury designation to only those reports that had substantial evidence that the injury, whether from entanglement or vessel collision, was likely to significantly impede the whale's locomotion or feeding in the immediate future, or had a high probability of leading to systemic and debilitating infection. There was no forecasting of how the entanglement or injury may increase the whale's susceptibility to further injury, namely from additional entanglements or vessel collisions. This conservative approach likely underestimates serious injury rates.

With these caveats, the total estimated annual average human-induced mortality and serious injury incurred by this stock (including fishery and non-fishery related causes) was 2.2 right whales per year (USA waters 1.4; Canadian waters, 0.8). As with entanglements, some injury or mortality due to ship strikes almost certainly passes undetected, particularly in offshore waters. Decomposed and/or unexamined animals (e.g., carcasses reported but not retrieved or necropsied) represent 'lost data', some of which may relate to human impacts. For these reasons, the figure of 2.2 right whales per year must be regarded as a minimum estimate.

Further, the small population size and low annual reproductive rate suggest that human sources of mortality may have a greater effect relative to population growth rates than for other whales. The principal factors believed to be retarding growth and recovery of the population are ship strikes and entanglement with fishing gear. Between 1970 and 1999, a total of 45 right whale mortalities were recorded (IWC 1999, Knowlton and Kraus 2000). Of these, 13 (28.9%) were neonates which are believed to have died from perinatal complications or other natural causes. Of the remainder, 16 (35.6%) were determined to be the result of ship strikes, three (6.7%) were related to entanglement in fishing gear (in two cases lobster gear, and one gillnet gear), and 13 (28.9%) were of unknown cause. At a minimum, therefore, 41.3% of the observed total for the period, and 59.4% of the 32 non-calf deaths, were attributable to human impacts.

Young animals, ages 0-4 years, are apparently the most impacted portion of the population (Kraus 1990). Finally, entanglement or minor vessel collisions may not kill an animal directly, but may weaken or otherwise affect it so that it is more likely to become vulnerable. Such was apparently the case with the two-year old right whale killed

by a ship off Amelia Island, Florida, in March 1991 after having carried gillnet gear wrapped around its tail region since the previous summer (Kenney and Kraus 1993). A similar fate befell right whale #2220, found dead on Cape Cod in 1996.

For waters of the northeastern USA, a present concern not yet completely defined, is the possibility of habitat degradation in Massachusetts and Cape Cod Bays due to a Boston sewage outfall which came on-line in September 2000.

Awareness and mitigation programs for reducing anthropogenic injury and mortality to right whales have been set up in two areas of concern. The first was initiated in 1992 off the coastal waters of the southeastern USA, and it has been upgraded and expanded annually. It involves both government and non-government organizations, including the Navy, Army Corps of Engineers, U.S. Coast Guard, and Florida and Georgia state agencies. In 1996, a program was established in the northeastern USA, largely in cooperation with the U.S. Coast Guard and the State of Massachusetts. In July 1999, a Mandatory Ship Reporting System was implemented in both the southeastern United States and in the Great South Channel/Cape Cod Bay/Massachusetts Bay critical habitats. This system requires vessels over 300 tons to report information about their identity, location, course and speed; in return, they receive information on right whale occurrence and recommendations on measures to avoid collisions with whales. This system is expected to provide much-needed information on patterns of vessel traffic in critical habitat areas.

Fishery-Related Serious Injury and Mortality

Reports of mortality and serious injury relative to PBR as well as total human impacts are contained in records maintained by the New England Aquarium and the Northeast Regional Office/NMFS (Table 1). From 1995 through 1999, 5 of 11 records of mortality or serious injury (including records from both USA and Canadian waters) involved entanglement or fishery interactions. The reports often do not contain the detail necessary to assign the entanglements to a particular fishery or location. However, based on re-examination of the records for the right whale observed entangled in pelagic drift gillnet in July 1993, which included the observer's documentation of lobster gear on the whale's tail stock, and subsequent entanglement reports of this whale, the suspected mortality of this whale was reassigned to the Gulf of Maine and USA mid-Atlantic lobster pot fisheries. In this case, the pre-existing entanglement of lobster gear was judged to have been sufficient cause of eventual mortality independent of the drift net entanglement. In another instance, a 2 year-old dead male right whale with lobster line through the mouth and deeply embedded at the base of the right flipper beached in Rhode Island in July 1995. This individual had been sighted previously, entangled, east of Georgia in December 1993, and again in August 1994 in Cape Cod Bay. In this case, the entanglement became a serious injury and (directly or indirectly) the cause of the mortality.

During the period of 1995 through 1999, there were at least three documented cases of entanglements for which the intervention of disentanglement teams averted a likely serious injury determination. Right whale #2110, a four year old female, was relieved of a substantial amount of gillnet gear in the Bay of Fundy on 9/16/95. On 6/5/1999, a two year old female, #2753, was found with a line through the mouth and trailing a norwegian ball and highflyer. The nature of the entanglement would likely not have allowed the whale to shed the gear, and over a prolonged period, the rope's chaffing would have likely caused systemic infection. Another two year old female, #2710, was sighted on 7/21/1999 wrapped in Canadian pot gear. A line passed through the mouth and around at least the right flipper. This entanglement would have become more constrictive as the whale grew.

In January 1997 (62 FR 33, Jan. 2, 1997), NMFS changed the classification of the Gulf of Maine and USA mid-Atlantic lobster pot fisheries from Category III to Category I based on examination of stranding and entanglement records of large whales from 1990 to 1994.

Fishery Information

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year, several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks), and currently provides observer coverage of vessels fishing south of Cape Hatteras. Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious

injuries have been documented in either the pelagic longline, pelagic pair trawl, or other fisheries monitored by NMFS. The only bycatch of a right whale documented by NMFS Sea Samplers was a female released from a pelagic drift gillnet as noted above.

In a recent analysis of the scarification of right whales, a total of 61.6% of the whales bore evidence of entanglements with fishing gear (Hamilton *et al.* 1998). Entanglement records maintained by NMFS Northeast Regional Office (NMFS, unpublished data) from 1970 through 1999, included at least 62 right whale entanglements or possible entanglements, including right whales in weirs, entangled in gillnets, and trailing line and buoys. An additional record (M. J. Harris, pers. comm.) reported a 9.1-10.6 m right whale entangled and released south of Ft. Pierce, Florida, in March 1982 (this event occurred in the course of a sampling program and was not related to a commercial fishery). Incidents of entanglements in groundfish gillnet gear, cod traps, and herring weirs in waters of Atlantic Canada and the USA east coast were summarized by Read (1994). In six records of right whales becoming entangled in groundfish gillnet gear in the Bay of Fundy and Gulf of Maine between 1975 and 1990, the right whales were either released or escaped on their own, although several whales have been observed carrying net or line fragments. A right whale mother and calf were released alive from a herring weir in the Bay of Fundy in 1976. For all areas, specific details of right whale entanglement in fishing gear are often lacking. When direct or indirect mortality occurs, some carcasses come ashore and are subsequently examined, or are reported as "floaters" at sea; however, the number of unreported and unexamined carcasses is unknown, but may be significant in the case of floaters. More information is needed about fisheries interactions and where they occur.

Other Mortality

Ship strikes are a major cause of mortality and injury to right whales (Kraus 1990, Knowlton & Kraus 2000). Records from 1995 through 1999 have been summarized in Table 1. For this time frame, the average reported mortality and serious injury to right whales due to ship strikes was 1.2 whales per year (USA waters, 0.8; Canadian waters, 0.4).

In the period January to March 1996, an 'unusual mortality event' was declared for right whales in southeastern USA waters. Five mortalities were reported, at least one of which (on 1/30/96) was attributable to ship strike. A second mortality (on 2/22/96) showed evidence of barotrauma but no proximate cause of death could be determined. Of the remaining three mortalities, two were calves (1/2/96 and 2/19/96), one of which may have died from birthing trauma (inconclusive). The third (2/7/96) was decomposed and could not be towed in for examination.

Table 1. Summarized records of mortality and serious injury likely to result in mortality, North Atlantic right whales, January 1995 through December 1999 . Causes of mortality or injury, assigned as primary or secondary, are based on records maintained by NMFS/NER and NMFS/SER.

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary		Notes
				Ship strike	Entang./ Fsh inter	
7/17/95	mortality, beached	2 y.o. male #2366	Middletown, RI		P	inshore lobster line through mouth, embedded deeply into bone at base of right flipper
8/13/95	serious injury, offshore	69+y.o. female, #1045	S. Georges Bank	P		large head wound exposing bone
10/20/95	mortality, beached	male, age unknown #2250	Long I., Nova Scotia	P		large gash on back, broken vertebrae
1/30/96	mortality, offshore	adult male, #1623	offshore GA	P		shattered skull, broken vertebrae and ribs
3/9/96	mortality, beached	male, age unknown #2220	Cape Cod MA	P	S	3.3 meter gash on back, broken skull, Canadian lobster gear wrapped through mouth and around tail
8/5/96	serious injury	unknown	SE of Gloucester, MA		P	unknown type of gear entangled around head
8/19/97	mortality	female, age unknown #2450	Bay of Fundy	P		necropsy found evidence of traumatic impact on left side and lower jaw
8/23/97	serious injury	5 y.o. male #2212	Bay of Fundy		P	reports from subsequent observations indicate the whale ingested some gear of an unknown type
8/29/97	serious injury	2 yr old female #2557	Bay of Fundy, Canada		P	Line of unknown origin tightly wrapped on body and one flipper, whale emaciated

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary		Notes
				Ship strike	Entang./ Fsh inter	
4/20/99	mortality	27+ y.o. female, #1014	Cape Cod, MA	P		Fractures to mandible and vertebral column, abrasion and edema around right flipper
5/10/99	mortality	adult female, #2030	80mi east of Cape Cod, MA		P	Constricting sink gillnet gear created deep, extensive lacerations

STATUS OF STOCK

The size of this stock is considered to be extremely low relative to OSP in the US Atlantic EEZ, and this species is listed as endangered under the ESA. The North Atlantic right whale is considered one of the most critically endangered populations of large whales in the world (Clapham *et al.* 1999). A Recovery Plan has been published and is in effect (NMFS 1991), with a revised plan due out late in 2000 or in 2001. Three critical habitats, Cape Cod Bay/Massachusetts Bay, Great South Channel, and the Southeastern USA, were designated by NMFS (59 FR 28793, June 3, 1994). The NMFS ESA 1996 Northern Right Whale Status Review concluded that the status of the western North Atlantic population of the northern right whale remains endangered; this conclusion was reinforced by the International Whaling Commission in both 1998 and 1999 (IWC 1998, 2000), which expressed grave concern regarding the status of this stock. The total level of human-caused mortality and serious injury is unknown, but reported human-caused mortality and serious injury has been a minimum of 2.2 right whales per year from 1995 through 1999. Given that PBR has been set to zero, no mortality or serious injury for this stock can be considered insignificant. This is a strategic stock because the average annual fishery-related mortality and serious injury exceeds PBR, and because the North Atlantic right whale is an endangered species. Relative to other populations of right whales, there are also concerns about growth rate, percentage of reproductive females, and calving intervals in this population.

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HUMPBACK WHALE (*Megaptera novaeangliae*): Gulf of Maine Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the western North Atlantic, humpback whales feed during spring, summer and fall over a range which encompasses the eastern coast of the United States (including the Gulf of Maine), the Gulf of St Lawrence, Newfoundland/Labrador, and western Greenland (Katona and Beard 1990). Other North Atlantic feeding grounds occur off Iceland and northern Norway, including off Bear Island and Jan Mayen (Christensen *et al.* 1992; Palsbøll *et al.*, 1997). These six regions represent relatively discrete subpopulations, fidelity to which is determined matrilineally (Clapham and Mayo 1987). Genetic analysis of mitochondrial DNA (mtDNA) has indicated that this fidelity has persisted over an evolutionary timescale in at least the Icelandic and Norwegian feeding grounds (Palsbøll *et al.* 1995, Larsen *et al.* 1996).

Previously, the North Atlantic humpback whale population was treated as a single stock for management purposes (Waring *et al.* 1999). Indeed, earlier genetic analyses (Palsbøll *et al.* 1995), based upon relatively small sample sizes, had failed to discriminate among the four western North Atlantic feeding areas. However, genetic analyses often reflect a timescale of thousands of years, well beyond those commonly used by managers. Accordingly, the decision was recently made to reclassify the Gulf of Maine as a separate feeding stock; this was based upon the strong fidelity by individual whales to this region, and the attendant assumption that, were this subpopulation wiped out, repopulation by immigration from adjacent areas would not occur on any reasonable management timescale. This reclassification has subsequently been supported by new genetic analysis based upon a much larger collection of samples than those utilized by Palsbøll *et al.* (1995). These analyses have found significant differences in mtDNA haplotype frequencies of the four western feeding areas, including the Gulf of Maine (Palsbøll *et al.* in prep.)

During the summers of 1998 and 1999, the Northeast Fisheries Science Center conducted surveys for humpback whales on the Scotian Shelf. The objective of these surveys was to establish the occurrence and population identity of the animals found in this region, which lies between the well-studied populations of the Gulf of Maine and Newfoundland. Photographs from the 1998 survey have now been compared to both the overall North Atlantic Humpback Whale Catalogue and a large regional catalogue from the Gulf of Maine (maintained by the College of the Atlantic and the Center for Coastal Studies, respectively). Only seven of 32 individual humpback whales identified on the Scotian Shelf were recognized in these comparisons, all of them from the Gulf of Maine. Preliminary comparisons of Scotian Shelf 1999 photographs (including some taken much further up the coast of Nova Scotia) revealed a similar rate of exchange with the Gulf of Maine. In contrast, almost all humpback whales identified elsewhere in the Gulf of Maine (including from the southwestern shore of Nova Scotia and Bay of Fundy area) have been previously observed in the Gulf of Maine region. Although only one Scotian Shelf match has so far been made to Newfoundland, instructive comparisons are compromised by the lack of effort in that region in recent years. Overall, while it is not possible to define the Gulf of Maine population by drawing a strict geographical boundary, it appears that the effective range of many members of this stock does not extend onto the Scotian Shelf.

In winter, whales from all six feeding areas (including the Gulf of Maine) mate and calve primarily in the West Indies, where spatial and genetic mixing among subpopulations occurs (Clapham *et al.* 1993; Katona and Beard, 1990; Palsbøll *et al.* 1997, Stevick *et al.* 1998). A few whales of unknown northern origin migrate to the Cape Verde Islands (Reiner *et al.*, 1996). In the West Indies, the majority of whales are found in the waters of the Dominican Republic, notably on Silver Bank, on Navidad Bank, and in Samana Bay (Balcomb and Nichols 1982, Whitehead and Moore 1982, Mattila *et al.* 1989, 1994). Humpback whales are also found at much lower densities throughout the remainder of the Antillean arc, from Puerto Rico to the coast of Venezuela (Winn *et al.* 1975, Levenson & Leapley 1978, Price 1985, Mattila and Clapham 1989).

It is apparent that not all whales migrate to the West Indies every winter, and that significant numbers of animals are found in mid- and high-latitude regions at this time (Swingle *et al.* 1993; Clapham *et al.* 1993). An increased number of sightings of young humpback whales in the vicinity of the Chesapeake and Delaware Bays occurred in 1992 (Swingle *et al.* 1993). Wiley *et al.* (1995) reported 38 humpback whale strandings which occurred during 1985-1992 in the USA mid-Atlantic and southeastern states. Humpback whale strandings increased, particularly along the Virginia and North Carolina coasts, and most stranded animals were sexually immature; in

addition, the small size of many of these whales strongly suggests that they had only recently separated from their mothers. Wiley *et al.* (1995) concluded that these areas are becoming an increasingly important habitat for juvenile humpback whales and that anthropogenic factors may negatively impact whales in this area. There have also been a number of wintertime humpback sightings in coastal waters of the southeastern USA (NMFS unpublished data; New England Aquarium unpublished data; Florida DEP, unpublished data). Whether the increased sightings represent a distributional change, or are simply due to an increase in sighting effort and/or whale abundance, is presently unknown.

A key question with regard to humpback whales off the southeastern and mid-Atlantic states is their population identity. Given the relative proximity of this region to the Gulf of Maine, a working hypothesis would be that these whales belong to a single population that ranges from the southeastern USA to Nova Scotia. NMFS-funded contracts to collect photographs and tissue samples from living and stranded humpbacks from this area were completed in 2000, and comparisons of the resulting materials should help to resolve this issue. Preliminary comparisons of mid-Atlantic humpback whale photographs with those in other collections have found that some of the animals concerned were previously observed in the Gulf of Maine. However, a better understanding of the stock identity of the mid-Atlantic animals awaits completion of the relevant photographic analyses in late 2000; molecular studies will probably not be completed until the following year.

Feeding is the principal activity of humpback whales in New England waters, and their distribution in New England waters has been largely correlated to prey species and abundance, although behavior and bottom topography are factors in foraging strategy (Payne *et al.* 1986, 1990). Humpback whales are frequently piscivorous when in these waters, feeding on herring (*Clupea harengus*), sand lance (*Ammodytes* spp.), and other small fishes. In the northern Gulf of Maine, euphausiids are also frequently taken (Paquet *et al.* 1997). Commercial depletion of herring and mackerel led to an increase in sand lance in the southwestern Gulf of Maine in the mid 1970s with a concurrent decrease in humpback whale abundance in the northern Gulf of Maine. Humpback whales were densest over the sandy shoals in the southwestern Gulf of Maine favored by the sand lance during much of the late 1970s and early 1980s, and humpback distribution appeared to have shifted to this area (Payne *et al.* 1986). An apparent reversal began in the mid 1980s, and herring and mackerel increased as sand lance again decreased (Fogarty *et al.* 1991). Humpback whale abundance in the northern Gulf of Maine increased dramatically during 1992-93, along with a major influx of herring (P. Stevick, pers. comm.). Humpback whales were few in nearshore Massachusetts waters in the 1992-93 summer seasons. They were more abundant in the offshore waters of Cultivator Shoal and the Northeast Peak on Georges Bank, and on Jeffreys Ledge; these latter areas are more traditional locations of herring occurrence. In 1996 and 1997, sand lance, and thus humpback whales, were once again abundant in the Stellwagen Bank area. However, unlike previous cycles, where an increase in sand lance corresponded to a decrease in herring, herring remained relatively abundant in the northern Gulf of Maine, and humpbacks correspondingly continued to occupy this portion of the habitat, where they also fed on euphausiids (unpublished data, Center for Coastal Studies and College of the Atlantic).

In early 1992, a major research initiative known as the Years of the North Atlantic Humpback (YONAH) (Smith *et al.* 1999) was initiated. This project was a large-scale, intensive study of humpback whales throughout almost their entire North Atlantic range, from the West Indies to the Arctic. During two primary years of field work, photographs for individual identification and biopsy samples for genetic analysis were collected from summer feeding areas and from the breeding grounds in the West Indies. Additional samples were collected from certain areas in other years. Results pertaining to the estimation of abundance and to genetic population structure are summarized below.

POPULATION SIZE

The overall North Atlantic population (including the Gulf of Maine) was recently estimated from genetic tagging data collected by the YONAH project in the breeding range at 4,894 males (95% c.i. 3,374-7,123) and 2,804 females (95% c.i. 1,776-4,463) (Palsbøll *et al.* 1997). Since the sex ratio in this population is known to be even (Palsbøll *et al.* 1997), the excess of males is presumed to be a result of sampling bias, lower rates of migration among females or sex-specific habitat partitioning in the West Indies; whatever the reason, the combined total is an underestimate of overall population size in this ocean. Photographic mark-recapture analyses from the YONAH project gave an ocean-basin-wide estimate of 10,600 (95% c.i. 9,300 to 12,100), and an additional genotype-based analysis yielded a similar but less precise estimate of 10,400 (95% c.i. 8,000 to 13,600) (Smith *et al.* 1999). The estimate of 10,600 (CV=0.067) is regarded as the best available estimate for the North Atlantic. In the northeastern North Atlantic, Øien (1990) estimated from sighting survey data that there were 1,100 humpback whales in the Barents Sea region.

Estimating abundance for the Gulf of Maine stock has proved problematic. Three approaches have been investigated: mark-recapture estimates, minimum population size, and line-transect estimates. Most of the mark-recapture estimates were affected by heterogeneity of sampling, which was heavily focused on the southwestern Gulf of Maine. However, an estimate of 652 (CV=0.15) derived from the more extensive and representative YONAH sampling in 1992 and 1993 was probably less subject to this bias.

The second approach uses photo-identification data to establish the minimum number of humpback whales known to be alive in a particular year, 1997. By determining the number of identified individuals seen either in that year, or in both a previous and subsequent year, it is possible to determine that at least 497 humpbacks were alive in 1997. This figure is also likely to be negatively biased, again because of heterogeneity of sampling. A similar calculation for 1992 (which would correspond to the YONAH estimate for the Gulf of Maine) yields a figure of 501 whales.

In the third approach, data were used from a 28 July to 31 August 1999 line-transect sighting survey conducted by a ship and airplane covering waters from Georges Bank to the mouth of the Gulf of St. Lawrence. Total track line length was 8,212 km. However, in light of the information on stock identity of Scotian Shelf humpback whales noted above, only the portions of the survey covering the Gulf of Maine were used; surveys blocks along the eastern coast of Nova Scotia were excluded. Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$ (Palka 2000). These surveys yielded an estimate of 816 humpbacks (CV = 0.45). Since the mark-recapture figures for abundance and minimum population size given above falls above the lower bound of the CV of the line transect estimate, we have chosen to use the latter as the best estimate of abundance for Gulf of Maine humpback whales. However, given that the rate of exchange between the Gulf of Maine and both the Scotian Shelf and mid-Atlantic region is not zero, this estimate is likely to be somewhat conservative and may need to be adjusted following further clarification of stock definition.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for Gulf of Maine humpback whales is 816 (C.V.=0.45). The minimum population estimate for this stock is 568.

Table 1. Summary of abundance estimates for Gulf of Maine humpback whales. CCS = Center for Coastal Studies. COA = College of the Atlantic.

Month/Year	Type	N	CV	Source
1992/93	Mark-recapture estimate	652	0.15	YONAH data
July/August 1999	Line transect	816	0.45	Palka 2000
1997	Minimum known to be alive	497	-	CCS+COA data

Current Population Trend

As detailed below, current data strongly suggest that the Gulf of Maine humpback whale stock is steadily increasing in size. This is consistent with the trend in the North Atlantic population overall (Smith *et al.* 1999) although there are no other feeding-area-specific estimates.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Barlow and Clapham (1997) applied an interbirth interval model to photographic mark-recapture data and estimated the population growth rate of the Gulf of Maine humpback whale stock at 6.5% (CV=0.012). Maximum net productivity is unknown for this population, although a theoretical maximum for any humpback population can be calculated using known values for biological parameters (Brandão *et al.* 1999). For the Gulf of Maine, data supplied by Barlow and Clapham (1997) and Clapham *et al.* (1995) gives values of 0.96 for survival rate, 6y as mean age at first parturition, 0.5 as the proportion of females, and 0.42 for annual pregnancy rate. From this, a maximum

population growth rate of 0.072 is obtained according to the method described by Brandão *et al.* (1999). This suggests that the observed rate of 6.5% (Barlow and Clapham 1997) is close to the maximum for this stock.

Current and maximum net productivity rates are unknown for the North Atlantic population overall. Katona and Beard (1990) suggested an annual rate of increase of 9%; however, the lower 95% confidence level was less than zero. The difference between the estimates of abundance calculated by Katona and Beard (1990) and by Smith *et al.* (1999) were interpreted by the latter as probably being due to population growth in the years between the two estimates. This assumed growth rate would be very similar to the growth rate of 6.5% calculated using an interbirth interval model for humpback whales in the Gulf of Maine (Barlow and Clapham 1997).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 568. The maximum productivity rate is 0.065 from Barlow and Clapham (1997). The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because this stock is listed as an endangered species under the Endangered Species Act (ESA). PBR for the Gulf of Maine humpback whale stock is 1.8 whales.

ANNUAL HUMAN-CAUSED SERIOUS INJURY AND MORTALITY

For the period 1995 through 1999, the total estimated human-caused mortality and serious injury to the Gulf of Maine humpback whale stock is estimated as 4.2 per year (USA waters, 3.8; Canadian waters, 0.4). This average is derived from two components: 1) incidental fishery interaction records 3.2 (USA waters, 2.8; Canadian waters, 0.4); and 2) records of vessel collisions, 1.0 (USA waters, 1.0; Canadian waters, 0). Note that in the 1996 and 1998 stock assessment reports, a six-year time frame was used to calculate the averages for additional fishery interactions and vessel collisions. A five-year period has been used since to be consistent with the time frames used for calculating the averages for the observed fishery and for other species. For the first time, Canadian records have been incorporated into the mortality and serious injury rates of this report to reflect the effective range of this stock as described above. It is also important to stress that serious injury determinations are made based upon the best available information at the time of writing; these determinations may change with the availability of new information. For the purposes of this report, discussion is primarily limited to those records considered confirmed human-caused mortalities or serious injuries.

To better assess human impacts (both vessel collision and net entanglement), and considering the number of decomposed and incompletely or unexamined animals in the records, there needs to be greater emphasis on the timely recovery of carcasses and complete necropsies. The literature and review of records described here suggest that there are significant human impacts beyond those recorded in the fishery observer data. For example, a study of entanglement-related scarring on the caudal peduncle of 134 individual humpback whales in the Gulf of Maine suggested that between 48% and 78% had experienced entanglements (Robbins and Mattila 1999). Decomposed and/or unexamined animals (e.g., carcasses reported but not retrieved or necropsied) represent ‘lost data’, some of which may relate to human impacts.

In addition, we have limited the serious injury designation to only those reports that had substantial evidence that the injury, whether from entanglement or vessel collision, was likely to significantly impede the whale’s locomotion or feeding in the immediate future, or had a high probability of leading to systemic and debilitating infection. There was no forecasting of how the entanglement or injury may increase the whale’s susceptibility to further injury, namely from additional entanglements or vessel collisions. For these reasons, the human impacts listed in this report must be considered a minimum estimate.

Background

As with right whales, human impacts (vessel collisions and entanglements) are factors which may be slowing recovery of the humpback whale population. There is an average of four to six entanglements of humpback whales a year in waters of the southern Gulf of Maine and additional reports of vessel-collision scars (unpublished data, Center for Coastal Studies). In addition, of 20 dead humpback whales (principally in the mid-Atlantic, where

decomposition state did not preclude examination for human impacts), Wiley *et al.* (1995) reported that six (30%) had major injuries possibly attributable to ship strikes, and five (25%) had injuries consistent with possible entanglement in fishing gear. One whale displayed scars that may have been caused by both ship strike and entanglement. Thus, 60% of the whale carcasses which were suitable for examination showed signs that anthropogenic factors may have contributed to, or been responsible for, their death. Wiley *et al.* (1995) further reported that all stranded animals were sexually immature, suggesting a winter or migratory segregation and/or that juvenile animals are more susceptible to human impacts. Humpback whale entanglements also occur in relatively high numbers in Canadian waters. Reports of collisions with fixed fishing gear set for groundfish around Newfoundland averaged 365 annually from 1979 to 1987 (range 174-813). An average of 50 humpback whale entanglements (range 26-66) were reported annually between 1979 and 1988, and 12 of 66 humpback whales that were entangled in 1988 died (Lien *et al.* 1988). Volgenau *et al.* (1995) also summarized existing data and concluded that in Newfoundland and Labrador, cod traps caused the most entanglements and entanglement mortalities (21%) of humpbacks between 1979 and 1992. They also reported that gillnets are the gear that has been the primary cause of entanglements and entanglement mortalities (20%) of humpbacks in the Gulf of Maine between 1975 and 1990.

Fishery-Related Serious Injuries and Mortalities

Two mortalities were observed in the pelagic drift gillnet fishery since 1989. In winter 1993, a juvenile humpback was observed entangled dead in a pelagic drift gillnet along the 200 m isobath northeast of Cape Hatteras; in early summer 1995, a humpback was entangled and dead in a pelagic drift gillnet on southwestern Georges Bank (see below).

Additional reports of mortality and serious injury relevant to comparison to PBR, as well as description of total human impacts, are contained in records maintained by the Northeast Regional Office/NMFS. A number of these records (11 entanglements involving lobster gear) from the 1990-94 period were used in the 1997 List of Fisheries classification (62 FR 33, Jan. 2, 1997). For this report, the records of dead, injured, and/or entangled humpbacks (either found stranded or at sea) for the period 1995 to 1999 were reviewed. Out of nearly 60 records, over 40 were eliminated from further consideration due to an absence of any evidence of human impact or, in the case of an entangled whale, it was documented that the animal had become disentangled. Of the remaining records, there were four mortalities attributable to fishery interactions, and 12 records where serious injuries were sustained from interactions with fisheries—a total of 16 records in the five-year period (Table 2). While these records are not statistically quantifiable in the same way as the observed fishery records, they provide some indication of the frequency of entanglements.

Fishery Information

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras. Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in the pelagic longline, pelagic pair trawl, or other fisheries monitored by NMFS.

In January 1997 (62 FR 33, Jan. 2, 1997), NMFS changed the classification of the Gulf of Maine and USA mid-Atlantic lobster pot fisheries from Category III to Category I based on examination of stranding and entanglement records of large whales from 1990 to 1994 (including 11 serious injuries or mortalities of humpback whales).

Pelagic Drift Gillnet

In 1996 and 1997, the NMFS issued management regulations which prohibited the operation of this fishery in 1997. The fishery was active during 1998. Then, in January 1999 NMFS issued a Final Rule to prohibit the use of drift net gear in the North Atlantic swordfish fishery (50 CFR Part 630). The estimated total number of hauls in the Atlantic pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995 and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine different vessels participated in this fishery at one time or

another between 1989 and 1993. In 1994 to 1998, there were 12, 11, 10, 0, and 11 vessels, respectively, in the fishery. Observer coverage, expressed as percent of sets, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, 64% in 1996, no fishery in 1997, and 99% coverage during 1998. Observer coverage dropped during 1996 because some vessels were deemed too small or unsafe by the contractor that provided observer coverage to NMFS. Fishing effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Total annual bycatch after 1993 were estimated separately for each year by summing the observed caught with the product of the average bycatch per haul and number of unobserved hauls as recorded in SEFSC logbooks. Variances were estimated using bootstrap re-sampling techniques. Estimated annual fishery-related mortality and serious injury (CV in parentheses) was 0 in 1994 (0), 1.0 in 1995 (0), 0 in 1996 (0), and 0 in 1998 (0). Since this fishery no longer exists, records of its incidental takes have been excluded from Table 2.

Table 2. Summarized records of mortality and serious injury likely to result in mortality, Gulf of Maine humpback whale stock, January 1995 - December 1999. Causes of mortality or injury, assigned as primary or secondary, are based on records maintained by NMFS/NER and NMFS/SER.

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary		Notes
				Ship strike	Entang./ Fsh.inter	
2/28/95	mortality	unknown	Cape Hatteras, North Carolina (35° 17' 75° 31')		P	stranded dead with gear wrapped around tail region
4/23/95	serious injury	length (est.) = 7.6m	Beaufort, NC		P	Sink gillnet wrapped several times around flukes
5/26/95	serious injury	length (est.)= 10m	Great South Channel (41° 16' 69° 20')		P	net and monofilament around tail region; whale anchored; mesh visible and gear trailing
6/4/95	mortality	8.9 m male	Virginia Beach, VA	P		several major lacerations indicative of collision with propeller
1/30/96	serious injury	juvenile	Northern Edge of Georges Bank (42° 26' 67° 30')		P	gear wrapped on body, some gear removed

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary		Notes
				Ship strike	Entang./ Fsh.inter	
2/22/96	serious injury	length (est.) = 8 m	Florida Keys		P	heavy line extending around maximum girth, pinning both pectorals; grooves/healed scars on dorsal ridge and on leading edge of both pectorals; fairly emaciated; disentangled
4/2/96	mortality	7.2 m female	Cape Story, Virginia Beach, Virginia	P		fresh dead; fractured left mandible; emaciated
5/9/96	mortality	6.7 m female	mouth of Delaware Bay	P		propeller cuts behind blowhole, moderate decomposition; ship strike
7/18/96	serious injury	length (est.) = 10 m	25 mi S of Bar Harbor Maine (44° 01' 68° 00')		P	disentanglement unsuccessful; weighted gear wrapped around tail stock; whale swimming abnormally
7/28/96	serious injury	length (est.) = 10m	SW corner of Stellwagen Bank, MA		P	entanglement involved mouth or flipper and line over tail; recent entanglement; extent of trailing gear unknown
10/7/96	serious Injury	unknown	Great South Channel (41° 04' 69° 10')		P	gear wrapped around tail and trailing 30 m behind whale
10/18/96	serious injury	unknown	Great South Channel (41° 00' 69° 10')		P	Whale entangled in steel cable
11/3/96	mortality	8.4 m male	Carrituck, North Carolina	P		acute trauma to skull found by necropsy
12/10/97	mortality	9.0 m male	Beaufort Inlet, NC	P		massive hemorrhage consistent with forceful blunt trauma

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary		Notes
				Ship strike	Entang./ Fsh.inter	
3/4/98	mortality	8.6 m female	Ocracoke Island, NC (35° 12' 75° 40')		P	Coast Guard present when whale drowned entangled in croaker gillnet gear
7/19/98	serious injury	age and sex unknown	Bay of Fundy, Canada		P	whale partially disentangled from gillnet gear, but swam away still badly wrapped
8/23/98	serious injury	adult, sex unknown	Montauk Pt., NY (40° 36' 70° 43')		P	whale anchored by offshore lobster gear, struggling to breathe; not relocated by Coast Guard search
11/5/98	mortality	8.9 m male	Nags Head, NC (35° 59' 75° 38')		P	Deep abrasions around tail stock with subdermal hemorrhaging
1/12/99	mortality	9.7m male	Martha's Vineyard, MA		P	Fresh and extensive rope marks on carcass with associated hemorrhaging
8/2/99	serious injury	9.4m estimated	Bay of Fundy, Canada		P	Single wrap of ½ inch poly line pinning flippers
9/23/99	serious injury	unknown	off Chatham, MA		P	Line out of mouth and several wraps around body; possibly anchored

Table notes:

1. The date sighted and location provided in the table are not necessarily when or where the serious injury or mortality occurred; rather, this information indicates when and where the whale was first reported beached, entangled, or injured.
2. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria as established by NERO/NMFS (62 FR 33, Jan. 2, 1997) have been used here. Some assignments may change as new information becomes available and/or when national standards are established.
3. Assigned cause based on best judgement of available data. Additional information may result in revisions.
4. Entanglements of juvenile whales may become more serious as the whale grows.

Other Mortality

Between November 1987 and January 1988, 14 humpback whales died after consuming Atlantic mackerel containing a dinoflagellate saxitoxin (Geraci *et al.* 1989). The whales subsequently stranded or were recovered in the vicinity of Cape Cod Bay and Nantucket Sound, and it is highly likely that other mortalities occurred during this event which went unrecorded. During the first six months of 1990, seven dead juvenile (7.6 to 9.1 m long) humpback whales stranded between North Carolina and New Jersey. The significance of these strandings is unknown, but is a cause for some concern.

As reported by Wiley *et al.* (1995) injuries possibly attributable to ship strikes are more common and probably more serious than those from entanglements. In the NER/NMFS records for 1995 through 1999, nine

records had some evidence of a collision with a vessel. Of these, five were mortalities as a result of the collision, three did not have sufficient information to confirm the collision as the cause of death, and for one the seriousness of the injury could not be assessed. This last record involved a whale watch vessel that collided with a humpback on 8/2/98. The whale was sighted after the collision with a large gash in its back, but was reported as “not struggling to breathe”.

STATUS OF STOCK

The North Atlantic humpback whale will be the topic of an International Whaling Commission Comprehensive Assessment in June 2001; this meeting will conduct a detailed review of all aspects of this population. Although the most recent estimates of abundance indicate continued population growth, the size of the humpback whale stock may be below OSP in the US Atlantic EEZ. This is a strategic stock because the humpback whale is listed as an endangered species under the ESA. A Recovery Plan has been published and is in effect (NMFS 1991). There are insufficient data to reliably determine population trends for humpback whales in the North Atlantic overall. The annual rate of population increase was estimated at 9% (Katona and Beard 1990, but with a lower 95% confidence level less than zero), and for the Gulf of Maine at 6.5% by Barlow and Clapham (1997). The total level of human-caused mortality and serious injury is unknown, but current data indicate that it is significant. This is a strategic stock because the average annual fishery-related mortality and serious injury exceeds PBR, and because the North Atlantic humpback whale is an endangered species.

Disturbance by whalewatching may prove to be an important habitat issue in some areas of this population's range, notably the coastal waters of New England where the density of whalewatching traffic is seasonally high. No studies have been conducted to address this question, and its impact (if any) on habitat occupancy and reproductive success is unknown.

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FIN WHALE (*Balaenoptera physalus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The Scientific Committee of the International Whaling Commission (IWC) has proposed stock boundaries for North Atlantic fin whales. Fin whales off the eastern USA, north to Nova Scotia and on to the southeastern coast of Newfoundland are believed to constitute a single stock under the present IWC scheme (Donovan 1991). However, the stock identity of North Atlantic fin whales has received relatively little attention, and whether the current stock boundaries define biologically isolated units has long been uncertain. The existence of a subpopulation structure was suggested by local depletions that resulted from commercial overharvesting (Mizroch *et al.* 1984).

A genetic study conducted by Bérubé *et al.* (1998) using both mitochondrial and nuclear DNA provided strong support for an earlier population model proposed by Kellogg (1929) and others. This postulates the existence of several subpopulations of fin whales in the North Atlantic and Mediterranean, with limited gene flow among them. Bérubé *et al.* (1998) also proposed that the North Atlantic population showed recent divergence due to climatic changes (*i.e.* postglacial expansion), as well as substructuring over even relatively short distances. The genetic data are consistent with the idea that different subpopulations use the same feeding ground, a hypothesis that was also originally proposed by Kellogg (1929).

Fin whales are common in waters of the US Atlantic Exclusive Economic Zone (EEZ), principally from Cape Hatteras northward (Figure. 1). Fin whales accounted for 46% of the large whales and 24% of all cetaceans sighted over the continental shelf during aerial surveys (CETAP 1982) between Cape Hatteras and Nova Scotia during 1978-82. While a great deal remains unknown, the magnitude of the ecological role of the fin whale is impressive. In this region fin whales are the dominant large cetacean species in all seasons, with the largest standing stock, the largest food requirements, and therefore the largest impact on the ecosystem of any cetacean species (Kenney *et al.* 1997; Hain *et al.* 1992).

There is little doubt that New England waters represent a major feeding ground for the fin whale. There is evidence of site fidelity by females, and perhaps some segregation by sexual, maturational or reproductive class on the feeding range (Aglar *et al.* 1993). Seipt *et al.* (1990) reported that 49% of identified fin whales on Massachusetts Bay area feeding grounds were resighted within years, and 45% were resighted in multiple years. While recognizing localized as well as more extensive movements, these authors suggested that fin whales on these grounds exhibited patterns of seasonal occurrence and annual return that are in some respects similar to those shown for humpback whales. This was reinforced by Clapham and Seipt (1991), who showed maternally directed site fidelity by fin whales in the Gulf of Maine. Information on life history and vital rates is also available in data from the Canadian

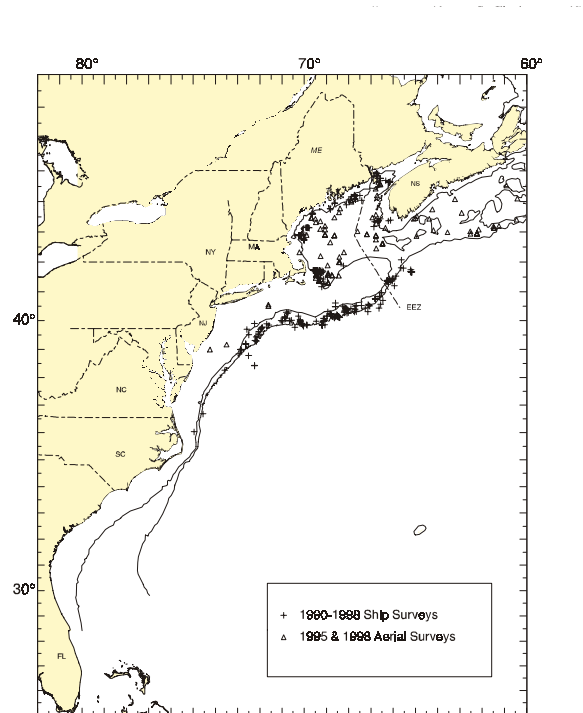


Figure 1. Distribution of fin whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and 1,000 m.

fishery, 1965-1971 (Mitchell 1974). In seven years, 3,528 fin whales were taken at three whaling stations. The station at Blandford, Nova Scotia, took 1,402.

Hain *et al.* (1992), based on an analysis of neonate stranding data, suggested that calving takes place during approximately four months from October to January in latitudes of the US mid-Atlantic region; however, it is unknown where calving, mating, and wintering for most of the population occurs. Results from the Navy's SOSUS program (Clark 1995) indicate a substantial deep-ocean component to fin whale distribution. It is likely that fin whales occurring in the US Atlantic EEZ undergo migrations into Canadian waters, open-ocean areas, and perhaps even subtropical or tropical regions. However, the popular notion that entire fin whale populations make distinct annual migrations like some other mysticetes has questionable support in the data; in the North Pacific, year-round monitoring of fin whale calls found no evidence for large-scale migratory movements (Watkins *et al.* 2000).

POPULATION SIZE

Two estimates of abundance from line transect surveys are available. An abundance of 2,200 (CV=0.24) fin whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence. Total track line length was 32,600 km. The ships covered waters between the 50- and 1000-fathom isobaths, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50-fathom isobath, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000-fathom isobath. Data collection and analysis methods used were described in Palka (1995).

A more recent estimate of 2,814 (CV=0.21) fin whales was derived from a 28 July to 31 August 1999 line-transect sighting survey conducted by a ship and airplane covering waters from Georges Bank to the mouth of the Gulf of St. Lawrence. Total track line length was 8,212 km. Similar to that used in the above 1995 Virginia to Gulf of St. Lawrence survey, shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$ (Palka 2000).

The latter abundance estimate is considered the best available for the western North Atlantic fin whale because it is relatively recent. However, this estimate must be considered extremely conservative in view of the known range of the fin whale in the entire western North Atlantic, and uncertainties regarding population structure and exchange between surveyed and unsurveyed areas.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for fin whales is 2,814 (CV=0.21). The minimum population estimate for the western North Atlantic fin whale is 2,362.

Current Population Trend

There are insufficient data to determine population trends for this species. Even at a conservatively estimated rate of increase, however, the numbers of fin whales may have increased substantially in recent years (Hain *et al.* 1992).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Based on photographically identified fin whales, Agler *et al.* (1993) estimated that the gross annual reproduction rate was at 8%, with a mean calving interval of 2.7 years.

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum

population size is 2362. The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because the fin whale is listed as endangered under the Endangered Species Act (ESA). PBR for the western North Atlantic fin whale is 4.7.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The number of fin whales taken at three whaling stations in Canada from 1965 to 1971 totaled 3,528 whales (Mitchell 1974). Reports of non-directed takes of fin whales are fewer over the last two decades than for other endangered large whales such as right and humpback whales. There was no reported fishery-related mortality or serious injury to fin whales in fisheries observed by NMFS during 1995 through 1999. A review of NER/NMFS anecdotal records from 1995 through 1999 yielded an average of 1.8 human caused mortalities per year— 0.6 per year resulting from fishery interactions/entanglements (USA waters, 0.4; Canadian waters, 0.2), and 1.2 due to vessel collisions (all in USA waters).

Fishery-Related Serious Injury and Mortality

No confirmed fishery-related mortality or serious injury of fin whales was reported in the Sea Sampling bycatch database; therefore, no detailed fishery information is presented here. A review of the records of stranded, floating or injured fin whales for the period 1995 through 1999 on file at NER/NMFS found three records with substantial evidence of fishery interactions causing mortality or serious injury. There was a live fin whale sighted entangled on 6/24/97 with line wrapped over its back. The animal appeared emaciated, and scarring visible on the leading edge of the dorsal fin and the whale’s left flank suggests this was a prolonged entanglement. Whether the entanglement initiated the whale’s decline in health is unclear, but the chronic stress of the entanglement is likely lethal given the whale’s depressed condition. The second record involved a whale that was found floating dead off Lubec, Maine, on 7/31/94. The whale had several wraps of line through the mouth, and about 30 wraps around the tail stock. The third entanglement was reported off Digby Neck, Nova Scotia on 9/28/98. The whale was found dead with gear wrapped through the mouth and ten wraps around the tail stock.

The three substantiated records provide a minimum annual rate of serious injury and mortality of 0.6 fin whales from fishery interactions. While these records are not statistically quantifiable in the same way as the observed fishery records, they give a minimum estimate of the frequency of entanglements for this species. In addition to the records above, there are eight records within the period that lacked substantial evidence of the severity of the entanglement for a serious injury determination, or that did not provide the detail necessary to determine if an entanglement had been a contributing factor in the mortality.

Other Mortality

After reviewing NER/NMFS records for 1995 through 1999, six were found that had sufficient information to confirm the cause of death as collisions with vessels. On 8/1/95, a 16.8m male was found on the bow of the ship “Royal Majesty”. The ship’s captain reported a major vibration was felt while transiting off Cape Cod, MA, enroute to Boston, Massachusetts. Another record was of a 10m female, found on 11/14/95 near Charleston, SC. The necropsy found extensive skeletal damage and hemorrhaging. On 12/20/96, a fin whale was found floating near the shipping docks in Savannah, Georgia. The necropsy found bruising, coagulated blood, and broken ribs on the right side of the animal. Another reported ship strike was a mortality in Salvo, North Carolina, discovered on 3/21/98. The whale had a large hematoma, a disarticulated spine and numerous broken vertebrae. On 2/10/99, a 15.5m male was found off Virginia Beach, Virginia, with a large external wound, extensive fractures to the vertebral column, and hemorrhaging. The sixth record was from Elizabeth, NJ, on 11/5/99, where a 16.2m male was found to have a large wound anterior of the blowhole, a severed left flipper, and shattered bones.

The above records constitute an annual rate of serious injury or mortality of 1.2 fin whales from collisions with vessels. NER/NMFS data holdings include seven additional records of fin whale collisions with vessels, but the available supporting documentation was not conclusive as to whether these constituted serious injury or were the proximal cause of the mortality. Continuing follow-up efforts may yield additional confirmed events from these records.

STATUS OF STOCK

The status of this stock relative to OSP in the USA Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine the population trend for fin whales. The total level of human-caused mortality and serious injury is unknown. The records on hand at NER/NMFS represent coverage of only a portion of the area surveyed for the population estimate for the stock. Despite this, the total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching a zero mortality and serious injury rate. This is a strategic stock because the fin whale is listed as an endangered species under the ESA. A Recovery Plan for fin whales will be in effect in 2000 (NMFS in press).

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SEI WHALE (*Balaenoptera borealis*): Nova Scotia Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Indications are that, at least during the feeding season, a major portion of the sei whale population is centered in northerly waters, perhaps on the Scotian Shelf (Mitchell and Chapman 1977). The southern portion of the species' range during spring and summer includes the northern portions of the US Atlantic Exclusive Economic Zone (EEZ) — the Gulf of Maine and Georges Bank. The period of greatest abundance there is in spring, with sightings concentrated along the eastern margin of Georges Bank and into the Northeast Channel area, and along the southwestern edge of Georges Bank in the area of Hydrographer Canyon (CETAP 1982). NMFS aerial surveys in 1999 and 2000 found concentrations of sei and right whales along the Northern Edge of Georges Bank in the spring. The sei whale is often found in the deeper waters characteristic of the continental shelf edge region (Hain *et al.* 1985). Mitchell (1975) similarly reported that sei whales off Nova Scotia were often distributed closer to the 2,000 m depth contour than were fin whales.

This general offshore pattern of sei whale distribution is disrupted during episodic incursions into more shallow and inshore waters. Although known to take piscine prey, sei whales (like right whales) are largely planktivorous, feeding primarily on euphausiids and copepods. In years of reduced predation on copepods by other predators, and thus greater abundance of this prey source, sei whales are reported in more inshore locations, such as the Great South Channel (in 1987 and 1989) and Stellwagen Bank (in 1986) areas (R.D. Kenney, pers. comm.; Payne *et al.* 1990). An influx of sei whales into the southern Gulf of Maine occurred in the summer of 1986 (Schilling *et al.* 1993). Such episodes, often punctuated by years or even decades of absence from an area, have been reported for sei whales from various places worldwide.

Based on analysis of records from the Blandford, Nova Scotia, whaling station, where 825 sei whales were taken between 1965 and 1972, Mitchell (1975) described two "runs" of sei whales, in June-July and in September-October. He speculated that the sei whale population migrates from south of Cape Cod and along the coast of eastern Canada in June and July, and returns on a southward migration again in September and October; however, such a migration remains unverified.

Mitchell and Chapman (1977) reviewed the sparse evidence on stock identity of northwest Atlantic sei whales, and suggested two stocks — a Nova Scotia stock and a Labrador Sea stock. The Nova Scotian stock includes the continental shelf waters of the northeastern USA, and extends northeastward to south of Newfoundland. The Scientific Committee of the IWC, while adopting these general boundaries, noted that the stock identity of sei whales (and indeed all North Atlantic whales) was a major research problem (Donovan 1991). In the absence of evidence to the contrary, the proposed IWC stock definition is provisionally adopted, and the "Nova Scotia stock" is used here as the management unit for this Stock Assessment. The IWC boundaries for this stock are from the USA east coast to Cape Breton, Nova Scotia, thence east to longitude 42° W.

POPULATION SIZE

The total number of sei whales in the US Atlantic EEZ is unknown. However, two abundance estimates are available for portions of the sei whale habitat (Table 1): from Nova Scotia during the 1970's, and in the US Atlantic EEZ during the springs of 1979-81.

Mitchell and Chapman (1977), based on tag-recapture data, estimated the Nova Scotia, Canada, stock to contain between 1,393 and 2,248 sei whales (Table 1). Based on census data, they estimated a minimum Nova Scotian population of 870 sei whales.

An abundance of 253 sei whales (CV=0.63) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate is based on data collected during the spring when the greatest proportion of the population off the northeast USA coast appeared in the study area. This estimate does not include a correction for dive-time or $g(0)$, the probability of detecting an animal group on the track line. The CETAP report suggested, however, that correcting the estimated abundance for dive time would increase the estimate to approximately the same as Mitchell and Chapman's (1977) tag-recapture estimate. This estimate is almost 20 years out of date and thus almost certainly does not reflect the current true population size; in addition, the estimate has a high degree of

uncertainty (i.e., it has a large CV), and it was estimated just after cessation of extensive foreign fishing operations in the region. There are no recent abundance estimates for the sei whale.

Table 1. Summary of abundance estimates for the Nova Scotia stock of the sei whale. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
1966 - 1972	Nova Scotia, Canada	1,393 to 2,248	None reported
spring 1978-82	Cape Hatteras, NC to Nova Scotia	253	0.63

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). A current minimum population size cannot be estimated because there are no current abundance estimates (within the last 10 years).

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is unknown. The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because the sei whale is listed as endangered under the Endangered Species Act (ESA). PBR for the Nova Scotia stock of the sei whale is unknown because the minimum population size is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

There are few if any data on fishery interactions or human impacts. There was no reported fishery-related mortality or serious injury to sei whales in fisheries observed by NMFS during 1994-1998. There are no reports of mortality, entanglement, or injury in the NEFSC or NE Regional Office databases; however, there is a report of a ship strike. The New England Aquarium documented a sei whale carcass hung on the bow of a container ship as it docked in Boston on November 17, 1994.

Fishery Information

There have been no reported entanglements or other interactions between sei whales and commercial fishing activities; therefore there are no descriptions of fisheries.

STATUS OF STOCK

The status of this stock relative to OSP in the USA Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine the population trends for sei whales. The total

level of human-caused mortality and serious injury is unknown, but the rarity of mortality reports for this species suggests that this level is insignificant and approaching a zero mortality and serious injury rate. This is a strategic stock because the sei whale is listed as an endangered species under the ESA. A Recovery Plan for sei whales will be in effect in 2000 (NMFS in press).

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BLUE WHALE (*Balaenoptera musculus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of the blue whale, *Balaenoptera musculus*, in the western North Atlantic generally extends from the Arctic to at least mid-latitudes. Blue whales are most frequently sighted in the waters off eastern Canada, with the majority of recent records from the Gulf of St. Lawrence (Sears *et al.* 1987). The species was hunted around Newfoundland in the first half of the 20th century (Sergeant 1966). The present Canadian distribution, broadly described, is spring, summer, and fall in the Gulf of St. Lawrence, especially along the north shore from the St. Lawrence River estuary to the Strait of Belle Isle and off eastern Nova Scotia. The species occurs in winter off southern Newfoundland and also in summer in Davis Strait (Mansfield 1985). Individual identification has confirmed the movement of a blue whale between the Gulf of St. Lawrence and western Greenland (R. Sears and F. Larsen, unpublished data), although the extent of exchange between these two areas remains unknown. **Similarly, a blue whale photographed by a NMFS large whale survey in August 1999 had previously been observed in the Gulf of St Lawrence in 1985 (R. Sears and P. Clapham, unpublished data).**

The blue whale is best considered as an occasional visitor in US Atlantic Exclusive Economic Zone (EEZ) waters, which may represent the current southern limit of its feeding range (CETAP 1982; Wenzel *et al.* 1988). All of the five sightings described in the foregoing two references were in August. Yochem and Leatherwood (1985) summarized records that suggested an occurrence of this species south to Florida and the Gulf of Mexico, although the actual southern limit of the species' range is unknown.

Using the U.S. Navy's SOSUS program, blue whales have been detected and tracked acoustically in much of the North Atlantic, including in subtropical waters north of the West Indies and in deep water east of the US EEZ (Clark 1995). Most of the acoustic detections were around the Grand Banks area of Newfoundland and west of the British Isles. Sigurjónsson and Gunnlaugsson (1990) note that North Atlantic blue whales appear to have been depleted by commercial whaling to such an extent that they remain rare in some formerly important habitats, notably in the northern and northeastern North Atlantic.

POPULATION SIZE

Little is known about the population size of blue whales except for in the Gulf of St. Lawrence area. Here, 308 individuals have been catalogued (Sears *et al.* 1987), but the data were deemed to be unusable for abundance estimation (Hammond *et al.* 1990). Mitchell (1974) estimated that the blue whale population in the western North Atlantic may number only in the low hundreds. R. Sears (pers. comm.) suggests that no present evidence exists to refute this estimate.

Minimum Population Estimate

The 308 recognizable individuals from the Gulf of St. Lawrence area which were catalogued by Sears *et al.* (1987) is considered to be a minimum population estimate for the western North Atlantic stock.

Current Population Trend

There are insufficient data to determine population trends for this species. Off western and southwestern Iceland, an increasing trend of 4.9% a year was reported for the period 1969-1988 (Sigurjónsson and Gunnlaugsson 1990), although this estimate should be treated with caution given the effort biases underlying the sightings data on which it was based.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 308. The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because the blue whale is listed as endangered under the Endangered Species Act (ESA). PBR for the western North Atlantic blue whale is 0.6.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

There are no confirmed records of mortality or serious injury to blue whales in the USA Atlantic EEZ. However, in March 1998 a dead 20-m (66-ft) male blue whale was brought into Rhode Island waters on the bow of a tanker. The cause of death was determined to be ship strike. Although it appears likely that the vessel concerned was responsible, the necropsy revealed some injuries that were difficult to explain in this context. The location of the strike was not determined; given the known rarity of blue whales in USA Atlantic waters, and the vessel’s port of origin (Antwerp), it seems reasonable to suppose that the whale died somewhere to the north of the US EEZ.

Fishery Information

No fishery information is presented because there are no observed fishery-related mortalities or serious injury.

STATUS OF STOCK

The status of this stock relative to OSP in the US Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine population trends for blue whales. The total level of human-caused mortality and serious injury is unknown, but it is believed to be insignificant and approaching a zero mortality and serious injury rate. This is a strategic stock because the blue whale is listed as an endangered species under the ESA. A Recovery Plan has been published (Reeves *et al.* 1998) and is in effect.

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MINKE WHALE (*Balaenoptera acutorostrata*): Canadian East Coast Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Minke whales have a cosmopolitan distribution in polar, temperate and tropical waters. In the North Atlantic there are four recognized populations — Canadian east coast, west Greenland, central North Atlantic, and northeastern North Atlantic (Donovan 1991). These four population divisions were defined by examining segregation by sex and length, catch distributions, sightings, marking data and pre-existing ICES boundaries; however, there are very few data from the Canadian east coast population.

Minke whales off the eastern coast of the United States are considered to be part of the Canadian east coast stock, which inhabits the area from the eastern half of the Davis Strait out to 45°W and south to the Gulf of Mexico. The relationship between this and the other three stocks is uncertain. It is also uncertain if there are separate stocks within the Canadian east coast stock.

The minke whale is common and widely distributed within the USA Atlantic Exclusive Economic Zone (EEZ) (CETAP 1982). There appears to be a strong seasonal component to minke whale distribution. Spring and summer are times of relatively widespread and common occurrence, and during this time they are most abundant in New England waters. During fall in New England waters, there are fewer minke whales, while during winter, the species appears to be largely absent. Like most other baleen whales, the minke whale generally occupies the continental shelf proper, rather than the continental shelf edge region. Records summarized by Mitchell (1991) hint at a possible winter distribution in the West Indies and in mid-ocean south and east of Bermuda. As with several other cetacean species, the possibility of a deep-ocean component to distribution exists but remains unconfirmed.

POPULATION SIZE

The total number of minke whales in the Canadian East Coast population is unknown. However, ~~seven~~^{six} estimates are available for portions of the habitat — a 1978-1982 estimate, a shipboard survey estimate from the summers of 1991 and 1992, a shipboard estimate from June-July 1993, an estimate made from a combination of a shipboard and aerial surveys conducted during July to September 1995, an aerial survey estimate of the entire Gulf of St. Lawrence conducted in August to September 1995, ~~and~~ an aerial survey estimate from the northern Gulf of St. Lawrence conducted during July and August 1996, ~~and an aerial/shipboard survey conducted from Georges Bank to the mouth of the Gulf of St. Lawrence during July and August 1999~~ (Table 1; Figure 1).

An abundance of 320 minke whales (CV=0.23) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982).

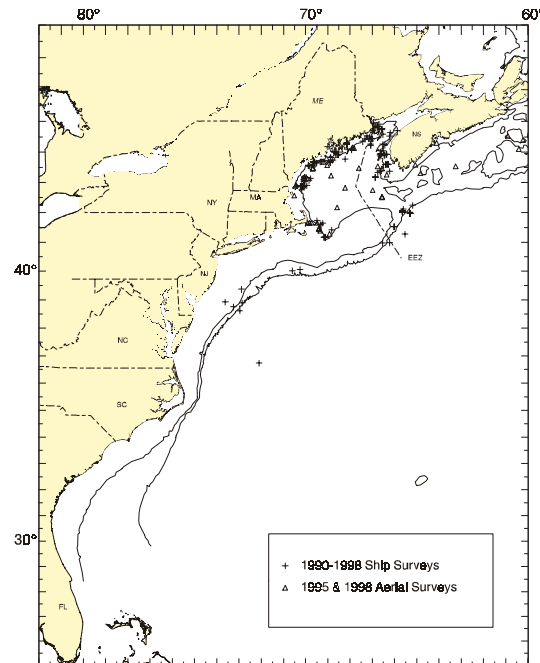


Figure 1. Distribution of minke whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and 1,000 m.

An abundance of 2,650 (CV=0.31) minke whales was estimated from two shipboard line transect surveys conducted during July to September 1991 and 1992 in the northern Gulf of Maine-lower Bay of Fundy region (Table 1). This population size is a weighted-average of the 1991 and 1992 estimates, where each annual estimate was weighted by the inverse of its variance, using methods as described in Palka (1995).

An abundance of 330 minke whales (CV=0.66) was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993).

An abundance of 2,790 (CV=0.32) minke whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; Palka *et al.* in review). Total track line length was 32,600 km. The ships covered waters between the 50 and 1000 fathom depth contour isobaths, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom depth contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom depth contour line. Data collection and analysis methods were described in Palka (1996).

Kingsley and Reeves (1998) estimated there were 1,020 (CV=0.27) minke whales in the entire Gulf of St. Lawrence in 1995 and 620 (CV=0.52) in the northern Gulf of St. Lawrence in 1996. During the 1995 survey, 8,427 km of track lines were flown in an area of 221,949 km² during August and September. During the 1996 survey, 3,993 km of track lines were flown in an area of 94,665 km² during July and August. Data were analyzed using Quenouille's jackknife bias reduction procedure on line transect methods that model the left truncated sighting curve. These estimates were uncorrected for visibility biases, such as $g(0)$.

An abundance of 2,998 (CV=0.19) minke whales was estimated from a July to August 1999 sighting survey conducted by a ship and airplane covering waters from Georges Bank to the mouth of the Gulf of St. Lawrence (Table 1; D. Palka, pers. comm.). Total track line length was 8,212 km. Similar to that used in the above 1995 Virginia to Gulf of St. Lawrence survey, shipboard data were analyzed using the modified direct duplicate method that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$ (Palka 2000).

The best available current abundance estimate for minke whales is the sum of the 1995 Georges Bank to Gulf of St. Lawrence survey (2,998 (CV=0.19)USA and the 1995 Gulf of St. Lawrence Canadian survey (1,020 (CV=0.27): 4,018 (CV=0.16)3,810 (CV=0.25), because these surveys are recent and provided the most complete coverage of the known habitat.

Table 1. Summary of abundance estimates for Canadian East Coast minke whales. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Row Number	Month/Year	Area	N_{best}	CV
1	Jul -Sep 1991-92	N. Gulf of Maine and Bay of Fundy	2,650	0.31
2	Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	330	0.66
3	Jul-Sep 1995	Virginia to mouth of Gulf of St. Lawrence	2,790	0.32
4	Aug-Sep 1995	Gulf of St. Lawrence	1,020	0.27
5	Jul-Sep 1995	Virginia to Gulf of St. Lawrence (SUM OF ROWS 3 and 4)	3,810	0.25
6	Jul-Aug 1996	northern Gulf of St. Lawrence	620	0.52

Row Number	Month/Year	Area	N _{best}	CV
7	July-Aug 1999	Georges Bank to mouth of Gulf of St. Lawrence	2,998	0.19
8	Aug-Sep 1995 + July-Aug 1999	Georges Bank to Gulf of St. Lawrence (SUM OF ROWS 4 AND 7)	4,018	0.16

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for minke whales is **4,018 (CV=0.16)** ~~3,810 (CV=0.25)~~. The minimum population estimate for the Canadian East Coast minke whale is **3,515 (CV=0.16)** ~~3,097 (CV=0.25)~~.

Current Population Trend

There are insufficient data to determine population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include: females mature when 6-8 years old; pregnancy rates are approximately 0.86 to 0.93; thus, the calving interval is between 1 and 2 years; calves are probably born during October to March, after 10 to 11 months gestation; nursing lasts for less than 6 months; maximum ages are not known, but for Southern Hemisphere minke whales the maximum age appears to be about 50 years (Katona *et al.* 1993; IWC 1991).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is **3,515 (CV=0.16)** ~~3,097 (CV=0.25)~~. The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the Canadian east coast minke whale is **353±**.

ANNUAL HUMAN-CAUSED MORTALITY AND INJURY

Recent minke whale takes have been observed or attributed to the ~~Atlantic pelagic drift gillnet, bluefin Atlantic~~ tuna purse seine, Gulf of Maine and mid-Atlantic lobster trap/pot, mid-Atlantic coastal gill net, and unknown fisheries; though all takes have not resulted in mortalities (Tables 2-~~5 and 3~~).

Data to estimate the mortality and serious injury of minke whales come from the USA Sea Sampling Program and from records of strandings and entanglements in USA waters. Estimates using the Sea Sampling Program data are discussed by fishery under the Fishery Information section below (Tables 2-~~and 3~~). Strandings and entanglement records are discussed under the lobster trap fishery, mid-Atlantic coastal gill net fishery, and “Unknown Fisheries” within the Fishery Information section and under the Other Mortality section (Tables 3 and 4 ~~and 5~~). For the purposes of this report, only those strandings and entanglement records considered confirmed human-caused mortalities or serious injuries are discussed.

~~After USA strandings and entanglement records are completely audited the mortality and serious injury estimate will be updated. Using the data presently available and audited (1994, 1996 to 1998)~~ During 1995 to 1998, the USA total annual estimated average human-caused mortality is **2.43±0** minke whales per year. This is derived

from three components: ~~0.1~~ 1 minke whales per year (CV=0.0) from USA ~~observed fisheries~~ using observer data, 2.2 ~~1.6~~ minke whales per year from USA fisheries using strandings and entanglement data, and 0.2 ~~3~~ minke whales per year from ship strikes.

Fishery Information

EARLIER INTERACTIONS

Little information is available about fishery interactions that took place before the 1990's. Read (1994) reported that a minke whale was found dead in a Rhode Island fish trap in 1976.

Distant-water Fleet

Prior to 1977, there was no documentation of marine mammal bycatch in the distant-water fleet (DWF) activities off the northeast coast of the USA. With implementation of the Magnuson Fisheries Conservation and Management Act in that year, an observer program was established which recorded fishery data and information on incidental bycatch of marine mammals. A minke whale was caught and released alive in the Japanese tuna longline fishery in 3,000 m of water, south of Lydonia Canyon on Georges Bank, in September 1986 (Waring *et al.* 1990). In 1982, there were 112 different foreign vessels; 16%, or 18, were Japanese tuna longline vessels operating along the USA east coast. This was the first year that the Northeast Regional Observer Program assumed responsibility for observer coverage of the longline vessels. Between 1983 and 1988, the numbers of Japanese longline vessels operating within the EEZ each year were 3, 5, 7, 6, 8, and 8, respectively. Observer coverage was 100%.

Northeast Sink Gillnet

Two minke whales were observed taken in the Northeast ~~multispecies~~ sink gillnet fishery between 1989 and the present. The take in July 1991, south of Penobscot Bay, Maine resulted in a mortality, and the take in October 1992, off the coast of New Hampshire near Jeffreys Ledge was released alive. There were approximately 349 vessels (full and part time) in the Northeast ~~multispecies~~ sink gillnet fishery in 1993 (Walden 1996) and 301 full and part time vessels in 1998. Observer coverage as a percentage of trips has been 1%, 6%, 7%, 5%, 7%, 5%, 4%, 6%, ~~and~~ 5%, ~~and~~ 6% for years 1990 to 1999~~8~~. Because no mortalities have been observed since 1991, the annual estimated average Northeast ~~multispecies~~ sink gillnet fishery-related mortality for minke whales is zero.

Herring Weir

A minke whale was trapped in and released alive from a herring weir off northern Maine in 1990. In USA and Canadian waters the herring weir fishery occurred from May to September each year along the southwestern shore of the Bay of Fundy, and scattered along the ~~coasts of~~ western Nova Scotia and northern Maine ~~coasts~~. In 1990 there were 56 active weirs in Maine (Read 1994). According to state ~~of Maine~~ officials, in 1998, the number of weirs in Maine waters dropped to nearly nothing due to the limited herring market (Jean Chenoweth, pers. comm.) ~~and in 2000 only 11 weirs were built (Molyneux 2000)~~. The ~~actual~~ number of active weirs in the USA is unknown. ~~It is also unknown if the active weirs incidentally take any marine mammals.~~

Pelagic Drift Gillnet

In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. The fishery was active during 1998. Then, in January 1999 NMFS issued a Final Rule to prohibit the use of drift net gear in the North Atlantic swordfish fishery (50 CFR Part 630). Four minke whale mortalities were observed in the Atlantic pelagic drift gillnet fishery during 1995 (~~Table 2~~). The estimated total number of hauls in the Atlantic pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991 to 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. In 1994 to 1998, there were 12, 11 10, 0, and 11 vessels, respectively, in the fishery (~~Table 2~~). Observer coverage, expressed as percent of sets, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, 64% in 1996, no fishery in 1997, and 99% coverage during 1998 (~~Table 2~~). Observer coverage dropped during 1996 because some vessels were deemed too small or unsafe by the contractor that provided observer coverage to NMFS. Fishing effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Total annual bycatch after 1993 was estimated separately for each year by summing the observed caught with the product of the average bycatch per

haul and number of unobserved hauls as recorded in SEFSC logbooks. Variances were estimated using bootstrap re-sampling techniques. Estimated annual fishery-related mortality and serious injury (CV in parentheses) was 0 for 1989 to 1994, 4.5 (0) for 1995, 0 for 1996 (Bisack 1997), and 0 for 1998. The fishery was closed during 1997. Estimated average annual mortality and serious injury related to this fishery during 1994 to 1996, and 1998 was 1.1 minke whales (CV=0.00) (Table 2). **There is no current mortality related to this fishery because the fishery closed in 1999.**

USA

~~Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program.~~

Atlantic Bluefin Tuna Purse Seine

In an ~~Atlantic bluefin~~ tuna purse seine off Stellwagen Bank, one minke whale was reported caught and released uninjured in 1991 (D. Beach, NMFS NE Regional Office, pers. comm.) and in 1996. The minke caught during 1991 escaped after a crew member cut the rope that was wrapped around the tail. The minke whale caught during 1996 escaped by diving beneath the net. The tuna purse seine fishery occurring between Cape Hatteras and Cape Cod is directed at small and medium bluefin and skip jack for the canning industry, while the fishery north of Cape Cod is directed at large medium and giant bluefin tuna (NMFS 1995). ~~These two latter~~ fisheries are entirely separate from other Atlantic tuna purse seine fisheries. Spotter aircraft were used to locate fish schools. The official start date, set by regulation, was August 15. Individual vessel quotas (IVQs) and a limited access system prevent a derby fishery situation. Catch rates for large mediums and giant tuna are high and consequently, the season usually only lasts a few weeks. The 1996 regulations allocated 250 MT (5 IVQs) with a minimum of 90% giants and 10% large mediums.

Limited observer data are available for the ~~Atlantic bluefin~~ tuna purse seine fishery. Out of 45 total trips made in 1996, 43 trips (95.6%) were observed. Forty-four sets were made on the 43 observed trips and all sets were observed. A total of 136 days were covered. No trips were observed during 1997 and 1998 **through 1999.**

Gulf of Maine and Mid-Atlantic Lobster Trap/Pot Fishery

The strandings and entanglement database, maintained by the New England Aquarium and the Northeast Regional Office/NMFS, reported seven minke whale mortalities and serious injuries that were attributed to the lobster fishery during 1990 to 1994, 1 in 1990 (may be serious injury), 2 in 1991 (one mortality and one serious injury), 2 in 1992 (both mortalities), 1 in 1993 (serious injury) and 1 in 1994 (mortality) (1997 List of Fisheries 62FR33, January 2, 1997). **The one confirmed minke whale mortality during 1995 was attributed to the lobster fishery (Tables 3 and 4).** ~~The 1995 entanglement records have not been completely audited. No confirmed mortalities or serious injuries of minke whales occurred in 1996 were confirmed.~~ From the four confirmed 1997 records one minke whale mortality was attributed to the lobster trap fishery (Tables 4 and 5). No fishery could be attributed to the other three 1997 minke mortalities (see unknown fisheries). No minke whale mortalities were attributed to a fishery for 1998 (Tables 3 and 4). **None of the five confirmed minke whale mortalities in 1999 were attributed to this fishery (Tables 3 and 4).**

There are three distinctly identified stock areas for the American lobster: 1) Gulf of Maine, 2) south of Cape Cod to Long Island Sound, and 3) Georges Bank and south to Cape Hatteras. In 1997, there were 3,431 vessels holding licenses to harvest lobsters in federal waters, 2,674 vessels licensed to use lobster pot gear in state waters, 675 vessels licensed to use bottom trawls and approximately 100 licenses to use dredge gear to harvest lobsters. **In 2000, there were 7,539 vessels from Maine to North Carolina holding licenses.** Lobsters are taken primarily by traps, with about 2-3% of the harvest being taken by mobile gear (trawlers and dredges). About 80% of lobsters were harvested from state waters. The offshore fishery in federal waters has developed in the past 10 to 15 years, largely due to technological improvements in equipment and lower competition in the offshore areas. In January 1997, NMFS changed the classification of the Gulf of Maine and USA mid-Atlantic lobster pot fisheries from Category III to Category I (1997 List of Fisheries 62FR33, January 2, 1997) based on examination of 1990 to 1994 stranding and entanglement records of large whales (including right, humpback and minke whales). **This fishery is operating under regulations from the Large Whale Take Reduction Plan (July 22, 1997; 62 FR 39157) and the**

federal American Lobster fishery plan (December 6, 1999; 64 FR 68228). Annual mortalities due to this fishery, as determined from strandings and entanglement records that have been audited, were 1 in 1991, 2 in 1992, 1 in 1994, 1 in 1995, 0 in 1996, 1 in 1997, and 0 in 1998 and 1999. Estimated average annual mortality related to this fishery during 1995 to 1998 (excluding 1995 because these data were not audited) was 0.40.5 minke whales per year (Table 34). The mortality estimate will be updated when all strandings and entanglement records have been audited.

Mid-Atlantic Coastal Gillnet

One minke whale, reported in the strandings and entanglement database, maintained by the New England Aquarium and the Northeast Regional Office/NMFS, was taken in a 6-inch gill net on 06 July 1998 off Long Island, New York (Tables 4 and 5). This take is being assigned to the mid-Atlantic coastal gillnet fishery. No minke whales have been taken from this fishery during observed trips in 1993 to 19998. In July 1993, an observer program was initiated in the USA Atlantic coastal gillnet fishery by the NEFSC Sea Sampling program. Twenty trips were observed during 1993. During 1994 and 1995, 221 and 382 trips were observed, respectively. This fishery, which extends from North Carolina to New York, is actually a combination of small vessel fisheries that target a variety of fish species, some of these vessels operate right off the beach, some using drift nets and others using sink nets. During 1998, it was estimated there were 302 full and part-time sink gillnet vessels and an undetermined number of drift gillnet vessels participating in this fishery. This is the number of unique vessels in the commercial landings database (Weighout) that report catch from fisheries during 1998 from the states of Connecticut to North Carolina. This does not include a small percentage of records where the vessel number was missing. Observer coverage, expressed as percent of tons of fish landed, was 5%, 4%, 3%, and 5%, and 2% for 1995 to 19998, respectively. Observed fishing effort was concentrated off New Jersey and scattered between Delaware and North Carolina from the beach to 50 miles off the beach.

Annual mortalities due to this fishery, as determined from strandings and entanglement records that have been audited, were 0 in 1991, 1992, 1994, 1995, 1996, and 1997, and 1999 and 1 in 1998. Estimated average annual mortality related to this fishery during 1995 to 1998 (excluding 1995 because these data were not audited) was 0.20.3 minke whales per year (Tables 3 and 4 and 5). The mortality estimate will be updated when all strandings and entanglement records have been audited.

Unknown Fisheries

The strandings and entanglement database, maintained by the New England Aquarium and the Northeast Regional Office/NMFS, included 36 records of minke whales within USA waters for 1975-1992. The gear included unspecified fishing net, unspecified cable or line, fish trap, weirs, seines, gillnets, and lobster gear. A review of these records is not complete. One confirmed entanglement was an immature female minke whale, entangled with line around the tail stock that came ashore on the Jacksonville, Florida, jetty on 31 January 1990 (R. Bonde, USFWS, Gainesville, FL, pers. comm.). The audited NE Regional Office entanglement/stranding database for 19953 to 19997 and also contains 33 records of minke whales, the confirmed mortalities are reported in Table 4. At this time the 1994, and 1996-1998 records have been audited (Tables 4 and 5). Other years will be available later. Mortalities that were likely a result of a fishery interaction with an unknown fishery include 3 in 1997, 5 in 1999, and 0 in other years. The examination of the minke entanglement records from 1997 indicate that 4 out of 4 confirmed records of mortality are likely a result of fishery interactions, one attributed to the lobster pot fishery (see above), and three not attributed to any particular fishery because the reports do not contain the necessary details. Of the 5 mortalities in 1999, 2 were attributed to a unknown trawl fishery and 3 to some other fishery (Tables 3 and 4).

In general, an entangled or stranded cetacean could be an animal that is part of a expanded bycatch estimate from an observed fishery and thus it is not possible to know if an entangled or stranded animal is an additional mortality. During 1997 to 1999, there were no minke whales observed taken in any fishery that participated in the Sea Sampling Program, therefore, the strandings where mortality was due to a fishery interaction can be added into the human-caused mortality estimate. however, there were three confirmed minke whale mortalities due to some unknown fishery. Thus, for 1997, three is the best minimum estimate of mortality due to one or more fisheries.

During 1995 to 1998 (excluding 1995 because the data have not been audited), as determined from strandings and entanglement records, the estimated average annual mortality is 0.48 minke whales per year in unknown trawl fisheries, and 1.2 minke whales per year in unknown fisheries (Table 34). The mortality estimate will be updated when all strandings and entanglement records have been audited.

CANADA

In Canadian waters, information about minke whale interactions with fishing gear is not well quantified or recorded, though some records are available. Read (1994) reported interactions between minke whales and gillnets in Newfoundland and Labrador, cod traps in Newfoundland, and herring weirs in the Bay of Fundy. Hooker *et al.* (1997) summarized bycatch data from a Canadian fisheries observer program that placed observers on all foreign fishing vessels operating in Canadian waters, on between 25 and 40% of large Canadian fishing vessels (greater than 100 feet long), and on approximately 5% of smaller Canadian fishing vessels. During 1991 through 1996, no minke whales were observed taken.

Herring Weirs

During 1980 and 1990, 15 of 17 minke whales were released alive from herring weirs in the Bay of Fundy. Due to the formation of a cooperative program between Canadian fishermen and biologists it is expected that now most minke whales will be able to be released alive (A. Westgate, pers. comm.).

In USA and Canadian waters the herring weir fishery occurred from May to September each year along the southwestern shore of the Bay of Fundy, and scattered along the ~~coasts of~~ western Nova Scotia and northern Maine ~~coasts~~. In 1990 there were 180 active weirs in western Bay of Fundy (Read 1994). According to Canadian DFO officials, for 1998, there were 225 weir licenses for herring weirs on the New Brunswick and Nova Scotia sides of the Bay of Fundy (60 from Grand Manan Island, 95 from Deer and Campobello Islands, 30 from Passamaquoddy Bay, 35 from East Charlotte area, and 5 from the Saint John area). The number of licenses has been fairly consistent since 1985 (Ed Trippel, pers. comm.), ~~but the~~. The number of active weirs is less than the number of licenses, ~~and the number has been decreasing every year, primarily due to competition with salmon mariculture sites of active weirs is less each year~~ (A. Read, pers. comm.).

Other Fisheries

Six minke whales were reported entangled during 1989 in the now non-operational groundfish gillnet fishery in Newfoundland and Labrador (Read 1994). One of these animals escaped and was still towing gear, the rest died.

Salmon gillnets in Canada, now no longer being used, had taken a few minke whales. In Newfoundland in 1979, one minke whale died in a salmon net. In Newfoundland and Labrador, between 1979 and 1990, it was estimated that 15% of the Canadian minke whale takes were in salmon gillnets, where a total of 124 minke whale interactions were documented in cod traps, groundfish gillnets, salmon gillnets, other gillnets and other traps. This fishery ended in 1993 as a result of an agreement between the fishermen and North Atlantic Salmon Fund (Read 1994).

Five minke whales were entrapped and died in Newfoundland cod traps during 1989. The cod trap fishery in Newfoundland closed in 1993 due to the depleted groundfish resources (Read 1994).

Table 2. ~~From data collected during observed trips, summary of the incidental mortality of minke whales (*Balaenoptera acutorostrata*) by commercial fishery, including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CV) and the mean annual mortality (CV in parentheses):~~

Fishery	Years	Vessels	Data Type [†]	Observer Coverage [‡]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Pelagic Drift Gillnet	94-98	1994=12 1995=11 1996=10 1997=NA [‡] 1998=13	Obs. Data Logbook	.87, .99; .64, NA [‡] ; .99	0; 4, 0, NA [‡] ; 0	0; 4.5 [‡] ; 0; NA [‡] ; 0	0	1.1 [‡] (0)

TOTAL		1.1 [‡] (0)
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⁺ Observer data (Obs. Data), used to measure bycatch rates, are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data, used to measure total effort for the pelagic drift gillnet fishery, are collected at the Southeast Fisheries Science Center (SEFSC).

[‡] The unit of effort for the observer coverage of the pelagic drift gillnet fishery is sets.

[‡] One vessel, not observed during 1995, recorded in the SEFSC mandatory logbook 1 set in a 10 day trip. If it is assumed that the vessel fished 1.4 sets per day, as estimated from the 1995 Sea Sampling data, the point estimate increases by 0.42 animals. However, the SEFSC mandatory logbook data were taken at face value, and therefore it was assumed 1 set was fished within this trip; thus the point estimate increases by 0.03 animals.

[‡] Fishery closed during 1997. So average bycatch is for 1994 to 1996, and 1998.

Table 23. Summary of minke whales (*Balaenoptera acutorostrata*) released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured).

Fishery	Years	Ratio	Injured	Uninjured
Tuna purse seine	96-98	0/0, NA ² , NA ² , NA ²	0, NA ² , NA ² , NA ²	1 ¹ , NA ² , NA ² , NA ²

NA=Not Available.

¹ The minke whale escaped by diving beneath the net.

² No observer coverage during 1997 and 1998 through 1999.

Table 34. From strandings and entanglement data, summary of confirmed incidental mortality of minke whales (*Balaenoptera acutorostrata*) by commercial fishery: includes years sampled (Years), number of vessels active within the fishery (Vessels), type of data used (Data Type), mortalities assigned to this fishery (Mortality), and mean annual mortality. See Table 5 for details.

Fishery	Years	Vessels	Data Type ¹	Observed Mortality	Mean Annual Mortality
GOM and mid-Atlantic Lobster Trap/Pot	94-98 95-99	1997=6880 2000=7539 licenses ²	Entanglement & Strandings	1, NA³; 1, 0, 1, 0, 0	0.45 ³ (0)
Mid-Atlantic Coastal Gillnet	94-98 95-99	1998=302 ³	Entanglement & Strandings	0, NA³; 0, 0, 0, 1, 0	0.23 ³
Unknown Trawl	95-99	NA	Entanglement & Strandings	0, 0, 0, 0, 2	0.4
Unknown Fisheries	94-98 95-99	NA	Entanglement & Strandings	0, NA³; 0, 0, 3, 0, 3	1.20-8 ³ (0)
TOTAL					2.21-6 ³ (0)

NA=Not Available.

¹ Data from records in the entanglement and strandings data base maintained by the New England Aquarium and the Northeast Regional Office/NMFS (Entanglement and Strandings).

² Number of vessels licensed to harvest lobsters in federal and state waters, with lobster traps/pots, bottom trawls, and dredge gear.

³ Number of sink gillnet vessels. Undetermined number of sink gillnet vessels.

³ 1995 stranding and entanglement records have not been audited, so average bycatch is an average of 1994, 1996, 1997, and 1998.

Table 45. Summarized records of mortality and serious injury likely to result in mortality. Canadian East Coast stock of minke whales, January 1994 - December 1998 (excluding 1995). This listing includes only confirmed records related to USA commercial fisheries and/or ship strikes in USA waters. Causes of mortality or injury, assigned as primary or secondary, are based on records maintained by NMFS/NER and NMFS/SER.

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary			Notes
				Ship strike	Entang./ Fsh.inter	Unk/ uncertain	
7/2/94	mortality	unk sex and size	off NH		P		Lobster fishery. Lobster lines (3 pair traps involved; line through mouth; one line around lower jaw; chafing on tail; whale brought up dead with traps.

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary			Notes
				Ship strike	Entang./ Fsh.inter	Unk/ uncertain	
8/23/95	mortality	unk sex and size	near Swan Island, ME		P		Lobster fishery. Entangled in inshore lobster gear.
5/15/97	mortality	female 5.5m (est)	Gloucester, MA (42°36' N 70°38' W)		P		Unknown fishery. Deep lacerations around tail stock, abrasions around flukes and mouth
5/16/97	mortality	female 5.5m (est)	Rockport, MA (42°40' N 70°35' W)		P		Unknown fishery. Abrasions around flukes; feeding prior to entanglement
8/14/97	mortality	female 2.8m	Jewell Island, ME (43°39' N 70°02' W)		P		Unknown fishery. Fresh lacerations on flukes and pectoral fins
8/30/97	mortality	female 8m (est)	Cape Small, ME (43°40' N 69°57' W)		P		Lobster fishery. Observed entangled in lobster gear by ME Marine Patrol
6/24/98	mortality	male 3.4m	Long Beach, NY (40° 34' N 73° 42' W)		P		Mid-Atlantic coastal gillnet fishery. Alive initially, then died in a 6-inch mesh gillnet.
12/12/98	mortality	unk sex and size	Cape Cod Bay, MA	P			Body of whale seen in wake of a whale watching vessel.
5/9/99	mortality	female 5.6m	Cape Lookout Bight (34° 61'N 76° 54'W)		P		Unknown fishery. Fresh open wounds around fluke and link marks from pectoral fins through mouth.
6/16/99	mortality	female 6.9m	Orleans, MA (41° 48'N 65° 56'W)		P		Unknown fishery. Extensive rope markings with hemorrhaging.
7/3/99	mortality	unk sex and size	Sakonnet River, RI (41°48'N 71°12'W)		P		Trawl fishery. 4.5 inch stretched mesh driven into rostrum.

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary			Notes
				Ship strike	Entang./ Fsh.inter	Unk/ uncertain	
8/2/99	mortality	unk sex and size	Point Judith Light, RI (41°23'N 71°28'W)		P		Trawl fishery. 6 inch stretched mesh tightly wrapped around rostrum.
10/2/99	mortality	female 7.2m	Provincetown, MA (42°03'N 70°21'W)		P		Unknown fishery. Rope marks on left gape of mouth, left pectoral fin, caudal peduncle, and dorsal and ventral surfaces of fluke blades.

Other Mortality

Minke whales have been and are still being hunted in the North Atlantic. From the Canadian East Coast population, documented whaling occurred from 1948 to 1972 with a total kill of 1,103 animals (IWC 1992). Animals from other North Atlantic populations are presently still being harvested at low levels.

USA

Minke whales inhabit coastal waters during much of the year and are subject to collision with vessels. According to the NE marine mammal entanglement and stranding database, on 7 July 1974, a necropsy on a minke whale suggested a vessel collision occurred; on 15 March 1992, a juvenile female minke whale with propeller scars was found floating east of the St. Johns channel entrance (R. Bonde, USFWS, Gainesville, FL, pers. comm.); and on 15 July 1996 the captain of a vessel reported they hit a minke whale offshore of Massachusetts. After reviewing this record, it was concluded the animal struck was not a serious injury or mortality. On 12 December 1998, a minke whale was struck and presumed killed by a whale watching vessel in Cape Cod Bay off Massachusetts.

During 1995 to 1999 the past five years, four years of stranding and entanglement records have been audited (1994, and 1996 to 1998). During these four years, one minke whale was confirmed struck by a ship, thus, there is an annual average of 0.23 minke whales per year struck by ships (Table 5).

~~All entangled and stranded minke whales that had injuries suggestive of a vessel collision or fishery interactions will be audited and summarized in the next stock assessment report.~~

CANADA

Whales and dolphins stranded between 1991 and 1996 on the coast of Nova Scotia were documented by the Nova Scotia Stranding Network (Hooker *et al.* 1997). Strandings on the beaches of Sable Island were documented by researchers with Fisheries and Oceans, Canada (Lucas and Hooker 2000+1997). Sable Island is approximately 170 km southeast of mainland Nova Scotia. Lucas and Hooker (2000) report four minke whales stranded on Sable Island between 1970 and 1998, one in spring 1982, one in January 1992, and a mother/calf in December 1998 (Table 6). ~~No minke whales were recorded stranded on Sable Island.~~ On the mainland of Nova Scotia, a total of seven reported minke whales stranded during 1991 to 1996 (Table 6). The 1996 stranded minke whale was released alive off Cape Breton on the Atlantic Ocean side, the rest were found dead. All the minke whales stranded between July and October. One was from the Atlantic Ocean side of Cape Breton, one from Minas Basin, one was at an unknown location, and the rest stranded in the vicinity of Halifax, Nova Scotia. It is unknown how many of the strandings can be attributed to fishery interactions.

Table 6. Documented number of stranded minke whales along the coast of Nova Scotia and on Sable Island by month and year, according to Hooker *et al.* (1997) and Lucas and Hooker (2000).

Year	Month	Number of strandings	
		Sable Isl.	Nova Scotia
1991	Sept		1
1992	Jan	1	
	July		1
1993	July		1
	Oct		2
1994	Aug		1
1996	July		1
1998	Dec	1	
TOTAL		2	7

STATUS OF STOCK

The status of minke whales, relative to OSP, in the USA Atlantic EEZ is unknown. The minke whale is not listed as endangered under the Endangered Species Act (ESA). The total fishery-related mortality and serious injury for this stock is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. This is not a strategic stock because estimated fishery-related mortality and serious injury does not exceed PBR and the minke whale is not listed as a threatened or endangered species under the ESA.

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SPERM WHALE (*Physeter macrocephalus*): North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of the sperm whale in the US EEZ occurs on the continental shelf edge, over the continental slope, and into mid-ocean regions (Figure 1). Waring *et al.* (1993) suggest that this offshore distribution is more commonly associated with the Gulf Stream edge and other features. However, the sperm whales that occur in the eastern US EEZ likely represent only a fraction of the total stock. The nature of linkages of the USA habitat with those to the south, north, and offshore is unknown. Historical whaling records compiled by Schmidly (1981) suggested an offshore distribution off the southeast USA, over the Blake Plateau, and into deep ocean. In the southeast Caribbean, both large and small adults, as well as calves and juveniles of different sizes are reported (Watkins *et al.* 1985). Whether the northwestern Atlantic population is discrete from northeastern Atlantic is currently unresolved. The International Whaling Commission recognizes one stock for the North Atlantic. Based on reviews of many types of stock studies, (*i.e.*, tagging, genetics, catch data, mark-recapture, biochemical markers, etc.) Reeves and Whitehead (1997) and Dufault *et al.* (1999) suggest that sperm whale populations have no clear geographic structure. There exists one tag return of a male tagged off Browns Bank (Nova Scotia) in 1966 and returned from Spain in 1973 (Mitchell 1975). Another male taken off northern Denmark in August 1981 had been wounded the previous summer by whalers off the Azores (Reeves and Whitehead 1997).

In the US EEZ waters, there appears to be a distinct seasonal cycle (CETAP 1982; Scott and Sadove 1997). In winter, sperm whales are concentrated east and northeast of Cape Hatteras. In spring, the center of distribution shifts northward to east of Delaware and Virginia, and is widespread throughout the central portion of the mid-Atlantic bight and the southern portion of Georges Bank. In summer, the distribution is similar but now also includes the area east and north of Georges Bank and into the Northeast Channel region, as well as the continental shelf (inshore of the 100m isobath) south of New England. In the fall, sperm whale occurrence south of New England on the continental shelf is at its highest level, and there remains a continental shelf edge occurrence in the mid-Atlantic bight. Similar inshore (<200m) observations have been made on the southwestern (Kenney, pers. comm) and eastern Scotian Shelf, particularly in the region of "the Gully" (Whitehead *et al.* 1991).

Geographic distribution of sperm whales may be linked to their social structure and their low reproductive rate and both of these factors have management implications. Several basic groupings or social units are generally recognized — nursery schools, harem or mixed schools, juvenile or immature schools, bachelor schools, bull schools or pairs, and solitary bulls (Best 1979; Whitehead *et al.* 1991). These groupings have a distinct geographical distribution, with females and juveniles generally based in tropical and subtropical waters, and males more wide-ranging and occurring in higher latitudes. Male sperm whales are present off and sometimes on the continental shelf

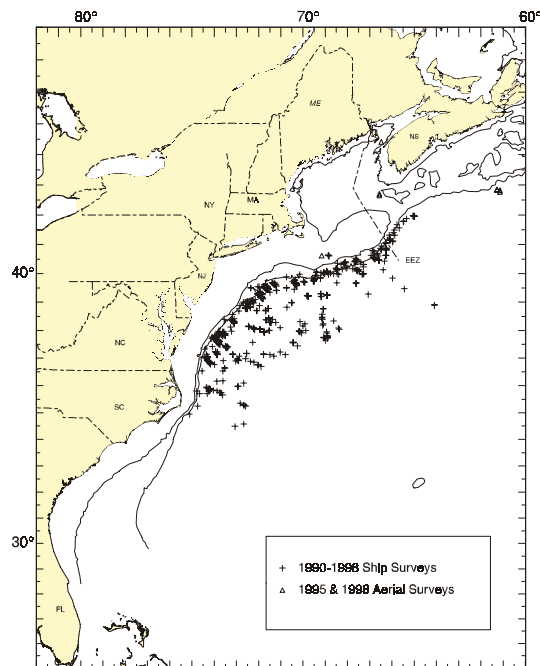


Figure 1. Distribution of sperm whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and 1,000 m.

along the entire east coast of Canada south of Hudson Strait, whereas, females rarely migrate north of the southern limit of the Canadian EEZ (Reeves and Whitehead 1997). However off the northeast USA, CETAP and NMFS/NEFSC sightings in shelf-edge and off-shelf waters included many social groups with calves/juveniles (CETAP 1981; Waring *et al.* 1992, 1993). The basic social unit of the sperm whale appears to be the mixed school of adult females plus their calves and some juveniles of both sexes, normally numbering 20-40 animals in all. There is evidence that some social bonds persist for many years.

POPULATION SIZE

Total numbers of sperm whales off the USA or Canadian Atlantic coast are unknown, although eight estimates from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). An abundance of 219 (CV=0.36) sperm whales was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP 1982). An abundance of 338 (CV=0.31) sperm whales was estimated from an August 1990 shipboard line transect sighting survey, conducted principally along the Gulf Stream north wall between Cape Hatteras and Georges Bank (Anon. 1990; Waring *et al.* 1992). An abundance of 736 (CV=0.33) sperm whales was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Waring *et al.* 1992; Waring 1998). An abundance of 705 (CV=0.66) and 337 (CV=0.50) sperm whales was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Anon. 1991). As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of 116 (CV=0.40) sperm whales was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for $g(0)$ or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 623 (CV=0.52) sperm whales was estimated from an August 1994 shipboard line transect survey conducted within a Gulf Stream warm-core ring located in continental slope waters southeast of Georges Bank (Table 1; Anon. 1994). Data were collected by two alternating teams that searched with 25x150 binoculars and an independent observer who searched by naked eye from a separate platform on the bow. Data were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for $g(0)$ or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 2,698 (CV=0.67) sperm whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; Palka *et al.* in review). Total track line length was 32,600 km. The ships covered waters between the 50 and 1000 fathom depth contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom depth contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom depth contour line. Data collection and analysis methods used were described in Palka (1996).

An abundance of 2,848 (CV=0.49) for sperm whales was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900 km of track line in waters north of Maryland (38° N) (Figure 1; Palka *et al.* in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of 1,854 (CV=0.53) for sperm whales was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 5,570 km of track line in waters south of Maryland (38°N) (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for sperm whales is the sum of the estimates from the two 1998 USA Atlantic surveys, 4,702 (CV=0.36), where the estimate from the northern USA Atlantic is 2,848 (CV=0.49) and from

the southern USA Atlantic is 1,854 (CV=0.53). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Because all the sperm whale estimates presented here were not corrected for dive-time, they are likely downwardly biased and an underestimate of actual abundance. The average dive-time of sperm whales is approximately 45 min (Whitehead *et al.* 1991; Watkins *et al.* 1993), therefore, the proportion of time that they are at the surface and available to visual observers is assumed to be low.

Although the stratification schemes used in the 1990-1998 surveys did not always sample the same areas or encompass the entire sperm whale habitat, they did focus on segments of known or suspected high-use habitats off the northeastern USA coast. The collective 1990-1998 data suggest that, seasonally, at least several thousand sperm whales are occupying these waters. The 1998 estimate is 1.7 times greater than the 1995 estimate, reflecting the contribution from the southern USA Atlantic. Sperm whale abundance may increase offshore, particularly in association with Gulf Stream and warm-core ring features; however, at present there is no reliable estimate of total sperm whale abundance in the western North Atlantic.

Table 1. Summary of abundance estimates¹ for the western North Atlantic sperm whale. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	116	0.40
Aug 1994	warm-core ring SE of Georges Bank	623	0.52
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	2,698	0.67
Jul-Sep 1998	Maryland to Gulf of St. Lawrence	2,848	0.49
Jul-Aug 1998	Florida to Maryland	1,854	0.53
Jul-Sep 1998	Gulf of St. Lawrence to Florida (COMBINED)	4,702	0.36

¹ As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore are not reported in this table.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for sperm whales is 4,702 (CV=0.36). The minimum population estimate for the western North Atlantic sperm whale is 3,505 (CV=0.36).

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. While more is probably known about sperm whale life history in other areas, some life history and vital rates information is available for the northwest Atlantic. These include: calving interval is 4-6 years; lactation period is 24 months; gestation period is 14.5-16.5 months; births occur mainly in July to November; length at birth is 4.0 m; length at sexual maturity 11.0-

12.5 m for males and 8.3-9.2 m for females; mean age at sexual maturity is 19 years for males and 9 years for females; and mean age at physical maturity is 45 years for males and 30 years for females (Best 1974; Lockyer 1981; Best *et al.* 1984; Rice 1989).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 3,505 (CV=0.36). The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because the sperm whale is listed as endangered under the Endangered Species Act (ESA). PBR for the western North Atlantic sperm whale is 7.0.

ANNUAL HUMAN-CAUSED MORTALITY

Four hundred twenty-four sperm whales were harvested in the Newfoundland-Labrador area between 1904-1972 and 109 male and no female sperm whales were taken near Nova Scotia in 1964-1972 (Mitchell and Kozicki 1984) in a Canadian whaling fishery. There was also a well-documented sperm whale fishery based on the west coast of Iceland. Other sperm whale catches occurred near West Greenland, the Azores, Madeira, Spain, Spanish Morocco, Norway (coastal and pelagic), Faroes, and British coastal. At present, because of their general offshore distribution, sperm whales are less likely to be impacted by humans and those impacts that do occur are less likely to be recorded. There has been no complete analysis and reporting of existing data on this topic for the western North Atlantic.

Total annual estimated average fishery-related mortality or serious injury to this stock during ~~1994-1998~~ **1995-1999** was zero sperm whales. Although, in 1995 one sperm whale was entangled in a pelagic drift gillnet and was released alive with gear around several body parts. Presently, this injury has not been used to estimate mortality.

Fishery Information

Three sperm whale entanglements have been documented from August 1993 to May 1998. In August 1993, a dead sperm whale, with longline gear wound tightly around the jaw, was found floating about 20 miles off Mt Desert Rock. In October 1994, a sperm whale was successfully disentangled from a fine mesh gillnet in Birch Harbor, Maine. In May 1997, a sperm whale entangled in net with three buoys trailing was sighted 130 nmi northwest of Bermuda. No information on the status of the animal was provided.

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and currently provides observer coverage of vessels fishing south of Cape Hatteras.

Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in the pelagic longline, pelagic pair trawl, Northeast multispecies sink gillnet, mid-Atlantic coastal gillnet, or North Atlantic bottom trawl ~~observed fisheries~~ **by NMFS Sea Samplers.**

Pelagic Drift Gillnet

Only two records exist in the present NEFSC bycatch database. In July 1990, a sperm whale was entangled and subsequently released (injured) from a pelagic drift gillnet near the continental shelf edge on southern Georges Bank. During June 1995, one sperm whale was entangled with “gear in/around several body parts” then released injured from a pelagic drift gillnet haul located on the shelf edge between Oceanographer and Hydrographer Canyons on Georges Bank.

The estimated total number of hauls in the pelagic drift net fishery increased from 714 in 1989 to 1144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, 1996, and 1998 were 233, 243, 232, 197, 164, 149, and 113 respectively. In 1996

and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (*i.e.*, permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine vessels participated in this fishery between 1989 and 1993. Since 1994, between 10 and 13 vessels have participated in the fishery. Observer coverage, percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, 64% in 1996, and 99% in 1998. The greatest concentrations of effort were located along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of total bycatch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata, assuming the 1990 injury was a mortality (Northridge 1996). Estimated annual fishery-related mortality and serious injury (CV in parentheses) was 2.2 sperm whales in 1989 (2.43), 4.4 in 1990 (1.77), 0 in 1991, 0 in 1992, 0 in 1993, 0 in 1994, 0 in 1995, 0 in 1996, NA in 1997, and 0 in 1998. ~~Estimated average annual mortality and serious injury related to this fishery during 1994-1998 was zero, assuming the 1995 injured sperm whale was not a serious injury.~~ **Since this fishery no longer exists, it has been excluded from Tables 2 and 3, (see Waring *et al.* 1999).**

Other Mortality

~~Thirteen~~ **Fourteen** sperm whale strandings have been documented along the USA Atlantic coast between Maine and Miami, Florida, during 1994- ~~1998~~ **1999** (NMFS unpublished data). One 1998 stranding off Florida showed signs of human interactions. The animal's head was severed, but it is unknown if it occurred pre or post-mortem. **In October 1999, a live sperm whale calf stranded on eastern Long Island, and was subsequently euthanized.**

In eastern Canada, five dead strandings were reported in Newfoundland/Labrador from 1987-1995; thirteen dead strandings along Nova Scotia from 1988- 1996; seven dead strandings on Prince Edward Island from 1988-1991; two dead strandings in Quebec in 1992; and ~~five dead~~ **thirteen animals in eight stranding events** on Sable Island, Nova Scotia from ~~1990-1996~~ **1970-1998** (Reeves and Whitehead 1997; Hooker *et al.* 1997; Lucas and Hooker 1997; Lucas and Hooker 2000). **Sex was recorded for eleven of the thirteen animals, and all were male, which is consistent with sperm whale distribution patterns (Lucas and Hooker 2000).**

Ship strikes are another source of human induced mortality. In May 1994 a ship-struck sperm whale was observed south of Nova Scotia (Reeves and Whitehead 1997), **and in May 2000 a merchant ship reported a strike in Block Canyon (NMFS, unpublished data).** In spring, Block Canyon is a major pathway for sperm whales entering southern New England continental shelf waters in pursuit of migrating squid (CETAP 1982; Scott and Sadove 1997).

STATUS OF STOCK

The status of this stock relative to OSP in USA Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine population trends. The current stock abundance estimate was based upon a small portion of the known stock range. Total fishery-related mortality and serious injury for this stock is less than 10% of the calculated PBR, and therefore can be considered to be insignificant and approaching a zero mortality and serious injury rate. This is a strategic stock because the species is listed as endangered under the ESA.

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CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of Cuvier's beaked whales is poorly known, and is based mainly on stranding records (Leatherwood *et al.* 1976). Strandings have been reported from Nova Scotia along the eastern USA coast south to Florida, around the Gulf of Mexico, and within the Caribbean (Leatherwood *et al.* 1976; CETAP 1982; Heyning 1989; Houston 1990; Mignucci-Giannoni *et al.* 1999). Stock structure in the North Atlantic is unknown.

Cuvier's beaked whale sightings have occurred principally along the continental shelf edge in the mid-Atlantic region off the northeast USA coast (CETAP 1982; Waring *et al.* 1992; NMFS unpublished data). Most sightings were in late spring or summer. Based on sighting data, this species is a rare inhabitant of waters off the northeast USA coast (CETAP 1982).

POPULATION SIZE

The total number of Cuvier's beaked whales off the eastern USA Canadian Atlantic coast is unknown.

However, eight estimates of the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). An abundance of 120 undifferentiated beaked whales (CV=0.71) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP 1982). An abundance of 442 (CV=0.51) undifferentiated beaked whales was estimated from an August 1990 shipboard line transect sighting survey, conducted principally along the Gulf Stream north wall between Cape Hatteras and Georges Bank (Anon. 1990; Waring *et al.* 1992). An abundance of 262 (CV=0.99) undifferentiated beaked whales was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Waring *et al.* 1992; Waring 1998). An abundance of 370 (CV=0.65) and 612 (CV=0.73) undifferentiated beaked whales was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Anon. 1991). As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of 330 (CV=0.66) undifferentiated beaked whales was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000 m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1;

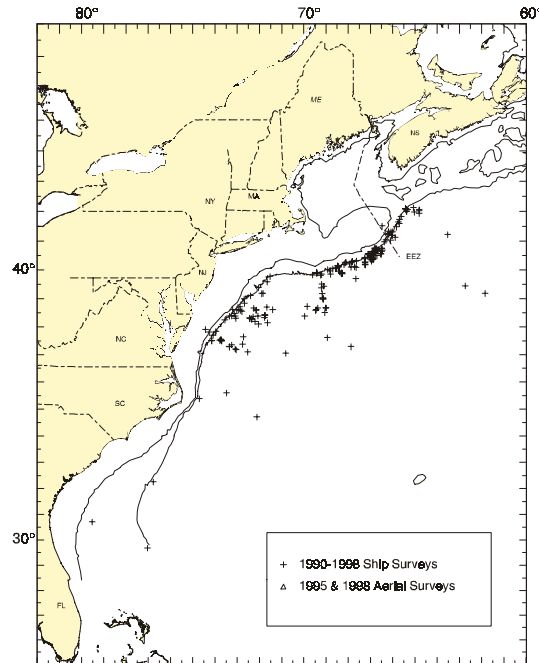


Figure 1. Distribution of beaked whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and 1,000 m.

Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for $g(0)$ or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 99 (CV=0.64) undifferentiated beaked whales was estimated from an August 1994 shipboard line transect survey conducted within a Gulf Stream warm-core ring located in continental slope waters southeast of Georges Bank (Table 1; Anon. 1994). Data were collected by two alternating teams that searched with 25x150 binoculars and an independent observer who searched by naked eye from a separate platform on the bow. Data were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for $g(0)$ or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 1,519 (CV=0.69) undifferentiated beaked whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; Palka *et al.* in review). Total track line length was 32,600 km. The ships covered waters between the 50 and 1000 fathom depth contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom depth contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom depth contour line. Data collection and analysis methods used were described in Palka (1996).

An abundance of 2,600 (CV=0.40) for undifferentiated beaked whales was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900 km of track line in waters north of Maryland (38° N) (Figure 1; Palka *et al.* in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of 596 (CV=0.50) for undifferentiated beaked whales was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 5,570 km of track line in waters south of Maryland (38°N) (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for undifferentiated beaked whales is the sum of the estimates from the two 1998 USA Atlantic surveys, 3,196 (CV=0.34), where the estimate from the northern USA Atlantic is 2,600 (CV=0.40) and from the southern USA Atlantic is 596 (CV=0.50). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Because the estimates presented here were not dive-time corrected, they are likely negatively biased and probably underestimate actual abundance. Given that *Mesoplodon* spp. prefers deep-water habitats (Mead 1989) the bias may be substantial.

Table 1. Summary of abundance estimates for the undifferentiated complex of beaked whales which include *Ziphius* and *Mesoplodon* spp. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	330	0.66
Aug 1994	warm-core ring SE of Georges Bank	99	0.64
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	1,519	0.69
Jul-Sep 1998	Maryland to Gulf of St. Lawrence	2,600	0.40
Jul-Aug 1998	Florida to Maryland	596	0.50
Jul-Sep 1998	Gulf of St. Lawrence to Florida (COMBINED)	3,196	0.34

* from data collected on the Twin Otter and AT-11, respectively.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for undifferentiated beaked whales is 3,196 (CV=0.34). The minimum population estimate for the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 2,419 (CV=0.34). It is not possible to determine the minimum population estimate of only Cuvier's beaked whales.

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include: length at birth is 2 to 3 m, length at sexual maturity 6.1 m for females, and 5.5 m for males, maximum age for females were 30 growth layer groups (GLG's) and for males was 36 GLG's, which may be annual layers (Mitchell 1975; Mead 1984; Houston 1990).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for the undifferentiated complex of beaked whales is 2,419 (CV=0.34). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for all species in the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 24. It is not possible to determine the PBR for only Cuvier's beaked whales.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The ~~1994-1998~~ 1995-1999 total average estimated annual fishery-related mortality of beaked whales in open fisheries in the US EEZ was ~~9.5 (CV=0.04)~~ zero.

Fishery Information

There is no historical information available that documents incidental mortality in either USA or Canadian Atlantic coast fisheries (Read 1994).

Current data on incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at Southeast Fisheries Science Center (SEFSC). In late 1992 and in 1993 the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and currently provides observer coverage of vessels fishing south of Cape Hatteras.

Total fishery-related mortality and serious injury cannot be estimated separately for each beaked whale species because of the uncertainty in species identification by fishery observers. The Atlantic Scientific Review Group advised adopting the risk-averse strategy of assuming that any beaked whale stock which occurred in the USA Atlantic EEZ might have been subject to the observed fishery-related mortality and serious injury.

Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in the pelagic longline, pelagic pair trawl, Northeast multispecies sink gillnet, mid-Atlantic coastal gillnet, or North Atlantic bottom trawl ~~observed~~ fisheries by NMFS Sea Samplers.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, 1996, and 1998 were 233, 243, 232, 197, 164, 143, and 113 respectively. In 1996 and 1997, NMFS issued management regulations with prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (*i.e.*, permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. ~~Since~~ From 1994 - 1998, between 10 and 13 vessels have participated in the fishery. (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, 64% in 1996, and 99% in 1998. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch for 1994 - 1998 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fisheries information. Variances were estimated using bootstrap re-sampling techniques. Bycatch of beaked whales has only occurred from Georges Canyon to Hydrographer Canyon along the continental shelf break and continental slope during July to October. Forty-six fishery-related beaked whale mortalities were observed between 1989 and 1998. These included: ~~23~~24 Sowerby's; 4 True's; 1 Cuvier's; and ~~18~~17 undifferentiated beaked whales. Recent analysis of biological samples (genetics and morphological analysis) have been used to determine species identifications for some of the by-caught animals. Estimation of by-catch mortalities by species is ~~still underway~~, are available for the 1994-1998 period. Prior estimates therefore the following estimates are for undifferentiated beaked whales. The estimated annual fishery-related mortality (CV in parentheses) was 60 in 1989 (0.21), 76 in 1990 (0.26), 13 in 1991 (0.21), 9.7 in 1992 (0.24), and 12 in 1993 (0.16). ~~4.8 in 1994 (0.08), 9.1 in 1995 (0), 13 in 1996 (0.12), NA in 1997, and 11 in 1998 (0) (Table 2).~~ The 1994-1998 estimates by 'species' are:

Year	Cuvier's	Sowerby's	True's	<i>Mesoplodon</i> spp.
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1994	1 (0.14)	3 (0.09)	0	0
1995	0	6 (0)	1 (0)	3 (0)
1996	0	9 (0.12)	2 (0.26)	2 (0.25)
1997	NA	NA	NA	NA
1998	0	2 (0)	2 (0)	7 (0)

During July 1996, one beaked whale was entangled and released alive with “gear in/around a single body part”. Annual mortality estimates do not include any animals injured and released alive. ~~Since this fishery no longer exists, Tables 2 and 3 have been deleted from this report (see Waring *et al.* 1999). The 1994-1998 total average estimated annual fishery-related mortality of beaked whales in the US EEZ was 9.5 (CV=0.04) (Table 2), assuming the 1996 injured beaked whale was not a serious injury.~~

Table 2. ~~Summary of the incidental mortality for the undifferentiated complex of beaked whales which include Cuvier’s beaked whale (*Ziphius cavirostris*), and *Mesoplodon* beaked whale, by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).~~

Fishery	Years	Vessels [†]	Data Type [‡]	Observer Coverage [§]	Observed Mortality	Estimated Mortality [¶]	Estimated CVs [¶]	Mean Annual Mortality
Pelagic Drift Gillnet	94-98[¶]	1994=12 1995=11 1996=10 1998=13	Obs. Data Logbook	.42, .87, .99, .64, NA, .99	5, 4, 9, 8, NA, 11	12, 4.8, 9.1[‡], 13, NA, 11	.16, .08, 0, .12, NA, 0	9.5[¶] (.04)
TOTAL								9.5 (.04)

[†] ~~1994–1996 shown, other years not available on an annual basis.~~

[‡] ~~Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data are used to measure total effort, and the data are collected at the Southeast Fisheries Science Center (SEFSC).~~

[§] ~~The observer coverage and unit of effort for the Pelagic Drift Gillnet is a set.~~

[¶] ~~For 1991–1993, pooled bycatch rates were used to estimate bycatch in months that had fishing effort but did not have observer coverage. This method is described in Northridge (1996). Because observer coverage increased substantially from 1994–1996, bycatch rates for this period are single year estimates.~~

[¶] ~~One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 0.8 animals. However, the SEFSC mandatory logbook data was taken at face value, and therefore it was assumed that 1 set was fished within this trip, and the point estimate would then increase by 0.1 animals.~~

[¶] ~~The fishery did not operate in 1997; the average annual mortality is based on the number of years (4; 1994–1998) that the fishery operated.~~

Other Mortality

From 1992- to 1998, a total of 49 beaked whales stranded along the USA Atlantic coast between Florida and Massachusetts (NMFS unpublished data). This includes: 28 (includes one tentative identification) Gervais'

beaked whales (one 1997 animal had plastics in esophagus and stomach, and Sargassum in esophagus; two 1998 animals that stranded in September in South Carolina showed signs of fishery interactions); 2 True's beaked whales; 5 Blainville's beaked whales; 1 Sowerby's beaked whales; 11 Cuvier's beaked whales (one 1996 animal had propeller marks) and 4 unidentified animals. The 1999 strandings data are under review.

Also, several unusual mass strandings of beaked whales in North Atlantic marine environments have been associated with naval activities. During the mid- to late 1980's multiple mass strandings of Cuvier's beaked whales (4 to about 20 per event) and small numbers of Gervais' beaked whale and Blainville's beaked whale occurred in the Canary Islands (Simmonds and Lopez-Jurado (1991). Twelve Cuvier's beaked whales that live stranded and subsequently died in the Mediterranean Sea on 12-13 May 1996 were associated with low frequency acoustic sonar tests conducted by the North Atlantic Treaty Organization (Frantzis 1998). In March 2000, thirteen beaked whales live stranded in the Bahamas; six beaked whales (2 Cuvier's, 2 Blainville's, and 2 unidentified) were returned to sea (NMFS unpublished data). The seven dead animals included: 5 Cuvier's, 1 Blainville's and 1 Gervais' beaked whales. Necropsy of six dead beaked whales revealed evidence of tissue trauma associated with sound production (NMFS unpublished data).

STATUS OF STOCK

The status of Cuvier's beaked whale relative to OSP in USA Atlantic EEZ is unknown. This species is not listed as threatened or endangered under the Endangered Species Act. ~~There are insufficient data to determine population trends and the level of human-caused mortality and serious injury is unknown because of uncertainty regarding species identification in observed fisheries. If one were to assume that the incidental fisheries mortality of the four *Mesoplodon* spp. and *Z. cavirostris* was random with respect to species (i.e., in proportion to their relative abundance), then the minimum population estimate for all of those stocks would need to sum to at least 950 in order for an annual mortality of 9.5 animals not to exceed the PBR of any one of these species. Because an assumption of unselective incidental fishing mortality is probably overly optimistic and represents a best case situation, it is likely that a combined minimum population estimate of substantially greater than 950 would be necessary for an annual mortality of 9.5 to not exceed the PBR of any one of these five stocks. The largest recent abundance estimate available for beaked whales in the western North Atlantic was 3,196 (CV=0.34) which would result in a minimum population estimate of 2,419 beaked whales; however, this estimate does not include a correction factor for submerged animals which may be substantial. Although a species specific PBR cannot be determined, the total fishery mortality and serious injury for this group is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. Although a species specific PBR cannot be determined, the permanent closure of the pelagic drift gillnet fishery has eliminated the principal known source of incidental fishery mortality. The total fishery mortality and serious injury for this group is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because of uncertainty regarding stock size and evidence of fishery-related human induced mortality and serious injury associated with naval activities.~~

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MESOPLODON BEAKED WHALES (*Mesoplodon* spp.): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Within the genus *Mesoplodon*, there are four species of beaked whales that reside in the northwest Atlantic. These include True's beaked whale, *Mesoplodon mirus*; Gervais' beaked whale, *M. europaeus*; Blainville's beaked whale, *M. densirostris*; and Sowerby's beaked whale, *M. bidens* (Mead 1989). These species are difficult to identify to the species level at sea; therefore, much of the available characterization for beaked whales is to genus level only. Stock structure for each species is unknown.

The distribution of *Mesoplodon* spp. in the northwest Atlantic is known principally from stranding records (Mead 1989; Nawojchik 1994; Mignucci-Giannoni *et al.* 1999). Off the northeast USA coast, beaked whale (*Mesoplodon* spp.) sightings have occurred principally along the southern edge of Georges Bank (CETAP, 1982; Waring *et al.* 1992; NMFS unpublished data). Most sightings were in late spring and summer. In addition, beaked whales were also sighted in Gulf Stream features during NEFSC 1990-1995 surveys (Waring *et al.* 1992; Anon 1994; Tove 1995; NMFS unpublished data).

True's beaked whale is a temperate-water species that has been reported from Cape Breton Island, Nova Scotia, to the Bahamas (Leatherwood *et al.* 1976; Mead 1989). It is considered rare in Canadian waters (Houston 1990).

Gervais' beaked whales are believed to be principally oceanic, and strandings have been reported from Cape Cod Bay to Florida, into the Caribbean and the Gulf of Mexico (Leatherwood *et al.* 1976; Mead 1989; NMFS unpublished data). This is the commonest species of *Mesoplodon* stranded along the USA Atlantic coast. The northernmost stranding was on Cape Cod.

Blainville's beaked whales have been reported from southwestern Nova Scotia to Florida, and are believed to be widely but sparsely distributed in tropical to warm-temperate waters (Leatherwood *et al.* 1976; Mead 1989, Nicolas *et al.* 1993). There are two records of strandings in Nova Scotia which probably represent strays from the Gulf Stream (Mead 1989). They are considered rare in Canadian waters (Houston 1990).

Sowerby's beaked whales have been reported from New England waters north to the ice pack, and individuals are seen along the Newfoundland coast in summer (Leatherwood *et al.* 1976; Mead 1989). Furthermore, a single stranding occurred off the Florida west coast (Mead 1989). This species is considered rare in Canadian waters (Lien *et al.* 1990).

POPULATION SIZE

The total number of *Mesoplodon* spp. beaked whales off the eastern USA and Canadian Atlantic coast is unknown.

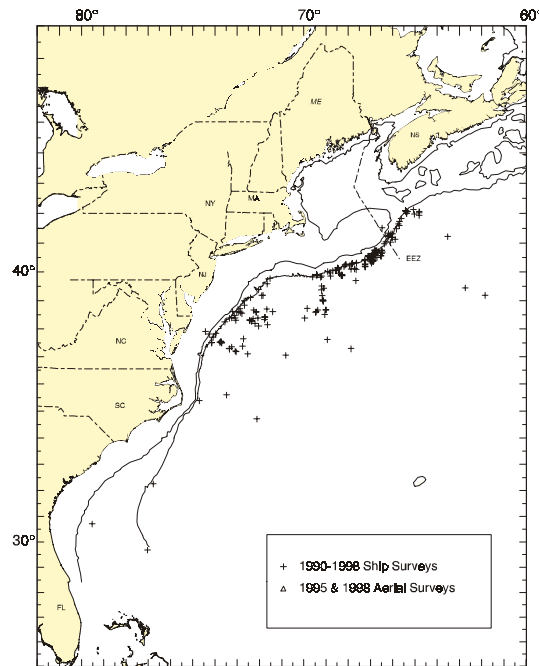


Figure 1. Distribution of beaked whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and 1,000 m.

However, eight estimates of the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). An abundance of 120 (CV=0.71) undifferentiated beaked whales was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP 1982). An abundance of 442 (CV=0.51) undifferentiated beaked whales was estimated from an August 1990 shipboard line transect sighting survey, conducted principally along the Gulf Stream north wall between Cape Hatteras and Georges Bank (Anon. 1990; Waring *et al.* 1992). An abundance of 262 (CV=0.99) undifferentiated beaked whales was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Waring *et al.* 1992; Waring 1998). An abundance of 370 (CV=0.65) and 612 (CV=0.73) undifferentiated beaked whales was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Anon. 1991). As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of 330 (CV=0.66) undifferentiated beaked whales was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for $g(0)$ or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 99 (CV=0.64) undifferentiated beaked whales was estimated from an August 1994 shipboard line transect survey conducted within a Gulf Stream warm-core ring located in continental slope waters southeast of Georges Bank (Table 1; Anon. 1994). Data were collected by two alternating teams that searched with 25x150 binoculars and an independent observer who searched by naked eye from a separate platform on the bow. Data were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for $g(0)$ or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 1,519 (CV=0.69) undifferentiated beaked whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; Palka *et al.* in review). Total track line length was 32,600 km. The ships covered waters between the 50 and 1000 fathom depth contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom depth contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom depth contour line. Data collection and analysis methods used were described in Palka (1996).

An abundance of 2,600 (CV=0.40) for undifferentiated beaked whales was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900 km of track line in waters north of Maryland (38° N) (Figure 1; Palka *et al.* in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of 596 (CV=0.50) for undifferentiated beaked whales was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 5,570 km of track line in waters south of Maryland (38°N) (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for undifferentiated beaked whales is the sum of the estimates from the two 1998 USA Atlantic surveys, 3,196 (CV=0.34), where the estimate from the northern USA Atlantic is 2,600 (CV=0.40) and from the southern USA Atlantic is 596 (CV=0.50). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Although the 1990-1998 surveys did not sample exactly the same areas or encompass the entire beaked whale habitat, they did focus on segments of known or suspected high-use habitats off the northeastern USA coast. The collective 1990-98 data suggest that, seasonally, at least several thousand beaked whales are occupying these

waters, highest levels of abundance in the Georges Bank region. Recent results suggest that beaked whale abundance may be highest in association with Gulf Stream and warm-core ring features.

Because the estimates presented here were not dive-time corrected, they are likely negatively biased and probably underestimate actual abundance. Given that *Mesoplodon* spp. prefers deep-water habitats (Mead 1989) the bias may be substantial.

Table 1. Summary of abundance estimates for the undifferentiated complex of beaked whales which include *Ziphius* and *Mesoplodon* spp. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	330	0.66
Aug 1994	warm-core ring SE of Georges Bank	99	0.64
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	1,519	0.69
Jul-Sep 1998	Maryland to Gulf of St. Lawrence	2,600	0.40
Jul-Aug 1998	Florida to Maryland	596	0.50
Jul-Sep 1998	Gulf of St. Lawrence to Florida (COMBINED)	3,196	0.34

* from data collected on the Twin Otter and AT-11, respectively.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for undifferentiated beaked whales is 3,196 (CV=0.34). The minimum population estimate for the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 2,419 (CV=0.34). It is not possible to determine the minimum population estimate of only *Mesoplodon* beaked whales.

Current Population Trend

There are insufficient data to determine the population trends for these species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include: length at birth is 2 to 3 m, length at sexual maturity 6.1 m for females, and 5.5 m for males, maximum age for females were 30 growth layer groups (GLG's) and for males was 36 GLG's, which may be annual layers (Mead 1984).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for the undifferentiated complex of beaked whales is 2,419 (CV=0.34). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for all species in the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 24. It is not possible to determine the PBR for only *Mesoplodon* beaked whales.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The ~~1994-1998~~ 1995-1999 total average estimated annual fishery-related mortality of beaked whales in open fisheries in the US EEZ was ~~9.5 (CV=0.04)~~ zero.

Fishery Information

There is no historical information available that documents incidental mortality in either USA or Canadian Atlantic coast fisheries (Read 1994).

Current data on incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993 the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and currently provides observer coverage of vessels fishing south of Cape Hatteras.

Total fishery-related mortality and serious injury cannot be estimated separately for each beaked whale species because of the uncertainty in species identification by fishery observers. The Atlantic Scientific Review Group advised adopting the risk-averse strategy of assuming that any beaked whale stock which occurred in the USA Atlantic EEZ might have been subject to the observed fishery-related mortality and serious injury.

Bycatch has been observed by NMFS sea samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in the pelagic longline, pelagic trawl, Northeast multispecies sink gillnet, mid-Atlantic coastal gillnet, or North Atlantic bottom trawl ~~observed~~ fisheries by NMFS sea samplers.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, 1996, and 1998 were 233, 243, 232, 197, 164, 143, and 113 respectively. In 1996 and 1997, NMFS issued management regulations with prohibited the operation of this fishery 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (*i.e.*, permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. ~~Since~~From 1994 to 1998, between 10 and 13 vessels have participated in the fishery. (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, 64% in 1996, and 99% in 1998. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch for 1994 - 1998 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fisheries information. Variances were estimated using bootstrap re-sampling techniques. Bycatch of beaked whales has only occurred from Georges Canyon to Hydrographer Canyon along the continental shelf break and continental slope during July to October. Forty-six fishery-related beaked whale mortalities were observed between 1989 and 1998. These included: ~~23~~24 Sowerby's; 4 True's; 1 Cuvier's; and ~~18~~17 undifferentiated beaked whales. Recent analysis of biological samples (genetics and morphological analysis) have been used to determine species identifications for some of the by-caught animals. Estimation of bycatch mortality by species ~~is still underway~~, available for the 1994-1998 period. Prior estimates therefore the following estimates are for undifferentiated beaked whales. The estimated annual fishery-related mortality (CV in parentheses) was 60 in 1989 (0.21), 76 in 1990 (0.26), 13 in 1991 (0.21), 9.7 in 1992 (0.24), and 12 in 1993 (0.16). ~~4.8 in 1994 (0.08), 9.1 in 1995 (0), 13 in 1996 (0.12), NA in 1997, and 11 in 1998 (0) (Table 2).~~ The 1994-1998 estimates by 'species' are:

Year	Cuvier's	Sowerby's	True's	<i>Mesoplodon</i> spp.
1994	1 (0.14)	3 (0.09)	0	0

1995	0	6 (0)	1 (0)	3 (0)
1996	0	9 (0.12)	2 (0.26)	2 (0.25)
1997	NA	NA	NA	NA
1998	0	2 (0)	2 (0)	7 (0)

During July 1996, one beaked whale was entangled and released alive with “gear in/around a single body part”. Annual mortality estimates do not include any animals injured and released alive. **Since this fishery no longer exists, Tables 2 and 3 have been deleted from this report (see Waring *et al.* 1999).** The 1994–1998 total average estimated annual fishery-related mortality of beaked whales in the US EEZ was 9.5 (CV=0.04) (Table 2), assuming the 1996 injured beaked whale was not a serious injury.

Table 2. Summary of the incidental mortality for the undifferentiated complex of beaked whales which include Cuvier’s beaked whale (*Ziphius cavirostris*), and *Mesoplodon* beaked whale, by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses):

Fishery	Years	Vessels [†]	Data Type [‡]	Observer Coverage [§]	Observed Mortality	Estimated Mortality [¶]	Estimated CVs [¶]	Mean Annual Mortality
Pelagic Drift Gillnet	94–98 [¶]	1994=12 1995=11 1996=10 1998=13	Obs. Data Logbook	.42, .87, .99, .64, NA, .99	5, 4, 9, 8, NA, 11	12, 4.8, 9.1 [§] , 13, NA, 11	.16, .08, 0, .12, NA, 0	9.5 [¶] (.04)
TOTAL								9.5 (.04)

[†] — 1994–1996 shown, other years not available on an annual basis.

[‡] — Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data are used to measure total effort, and the data are collected at the Southeast Fisheries Science Center (SEFSC).

[§] — The observer coverage and unit of effort for the Pelagic Drift Gillnet is a set.

[¶] — For 1991–1993, pooled bycatch rates were used to estimate bycatch in months that had fishing effort but did not have observer coverage. This method is described in Northridge (1996). Because observer coverage increased substantially from 1994–1996, bycatch rates for this period are single year estimates.

[§] — One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 0.8 animals. However, the SEFSC mandatory logbook data was taken at face value, and therefore it was assumed that 1 set was fished within this trip, and the point estimate would then increase by 0.1 animals.

[¶] — The fishery did not operate in 1997; the average mortality is based on the number of years (4; 1994–1998) that the fishery operated.

Other Mortality

From 1992- to 1998, a total of 49 beaked whales stranded along the USA Atlantic coast between Florida and Massachusetts (NMFS unpublished data). This includes: 28 (includes one tentative identification) Gervais' beaked whales (one 1997 animal had plastics in esophagus and stomach, and Sargassum in esophagus; two 1998 animals that stranded in September in South Carolina showed signs of fishery interactions); 2 True's beaked whales;

5 Blainville's beaked whales; 1 Sowerby's beaked whales; 11 Cuvier's beaked whales (one 1996 animal had propeller marks) and 4 unidentified animals. The 1999 strandings data are still under review.

One stranding of Sowerby's beaked whale was recorded on Sable Island between 1970-1998 (Lucas and Hooker 2000). The whale's body was marked by wounds made by the cookiecutter shark (*Isistius brasiliensis*), which has previously been observed on beaked whales (Lucas and Hooker 2000).

Also, several unusual mass strandings of beaked whales in North Atlantic marine environments have been associated with naval activities. During the mid- to late 1980's multiple mass strandings of Cuvier's beaked whales (4 to about 20 per event) and small numbers of Gervais' beaked whale and Blainville's beaked whale occurred in the Canary Islands (Simmonds and Lopez-Jurado (1991). Twelve Cuvier's beaked whales that live stranded and subsequently died in the Mediterranean Sea on 12-13 May 1996 was associated with low frequency acoustic sonar tests conducted by the North Atlantic Treaty Organization (Frantzis 1998). In March 2000, thirteen beaked whales live stranded in the Bahamas; six beaked whales (2 Cuvier's, 2 Blainville's, and 2 unidentified) were returned to sea (NMFS unpublished data). The seven dead animals included: 5 Cuvier's, 1 Blainville's and 1 Gervais' beaked whales. Necropsy of six dead beaked whales revealed evidence of tissue trauma associated with sound production (NMFS unpublished data).

STATUS OF STOCK

The status of *Mesoplodon* beaked whales relative to OSP in USA Atlantic EEZ is unknown. These species are not listed as threatened or endangered under the Endangered Species Act. ~~There are insufficient data to determine population trends and the level of human-caused mortality and serious injury is unknown because of uncertainty regarding species identification in observed fisheries. If one were to assume that the incidental fisheries mortality of the four *Mesoplodon* spp. and *Z. cavirostris* was random with respect to species (i.e., in proportion to their relative abundance), then the minimum population estimate for all of those stocks would need to sum to at least 950 in order for an annual mortality of 9.5 animals not to exceed the PBR of any one of these species. Because an assumption of unselective incidental fishing mortality is probably overly optimistic and represents a best case situation, it is likely that a combined minimum population estimate of substantially greater than 950 would be necessary for an annual mortality of 9.5 to not exceed the PBR of any one of these five stocks. The largest recent abundance estimate available for beaked whales in the western North Atlantic was 3,196 (CV=0.34) which would result in a minimum population estimate of 2,419 beaked whales; however, this estimate does not include a correction factor for submerged animals which may be substantial. Although a species specific PBR cannot be determined, the total fishery mortality and serious injury for this group is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate.~~ Although a species specific PBR cannot be determined, the permanent closure of the pelagic drift gillnet fishery has eliminated the principal known source of incidental fishery mortality. The total fishery mortality and serious injury for this group is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because of uncertainty regarding stock size and evidence of fishery-related human induced mortality and serious injury associated with naval activities.

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RISSO'S DOLPHIN (*Grampus griseus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Risso's dolphin is distributed worldwide in tropical and temperate seas. Risso's dolphins generally have an oceanic range, and occur along the Atlantic coast of North America from Florida to eastern Newfoundland (Leatherwood *et al.* 1976; Baird and Stacey 1990). Off the northeast USA coast, Risso's dolphins are distributed along the continental shelf edge from Cape Hatteras northward to Georges Bank during the spring, summer, and autumn (CETAP 1982; Payne *et al.* 1984). In winter, the range begins at the mid-Atlantic bight and extends further into oceanic waters (Payne *et al.* 1984). In general, the population occupies the mid-Atlantic continental shelf edge year round, and is rarely seen in the Gulf of Maine (Payne *et al.* 1984). During 1990, 1991 and 1993, spring/summer surveys conducted in continental shelf edge and deeper oceanic waters had sightings of Risso's dolphins associated with strong bathymetric features, Gulf Stream warm-core rings, and the Gulf Stream north wall (Waring *et al.* 1992; Waring 1993). There is no information on stock differentiation of Risso's dolphin in the western North Atlantic.

POPULATION SIZE

Total numbers of Risso's dolphins off the USA or Canadian Atlantic coast are unknown, although eight estimates from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). An abundance of 4,980 Risso's dolphins (CV=0.34) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental, shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP 1982). An abundance of 11,017 (CV=0.58) Risso's dolphins was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Waring *et al.* 1992; Waring 1998). An abundance of 6,496 (CV=0.74) and 16,818 (CV=0.52) Risso's dolphins was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Anon. 1991). As recommended in the GAMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of 212 (CV=0.62) Risso's dolphins was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using

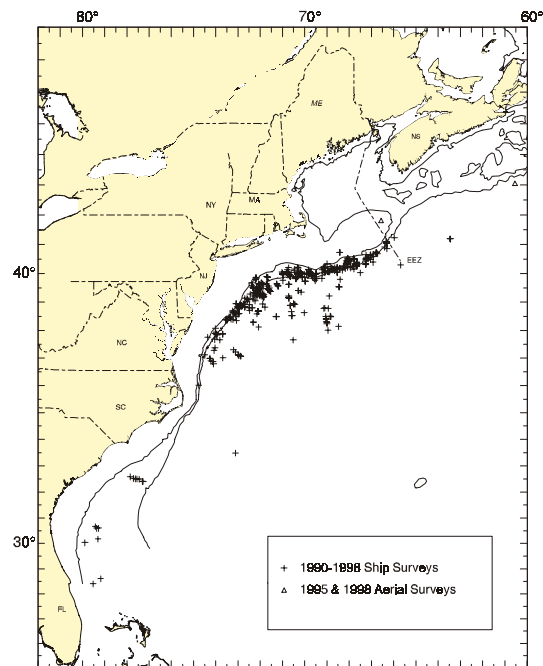


Figure 1. Distribution of Risso's dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and 1,000 m.

DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for $g(0)$ or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 5,587 (CV=1.16) Risso's dolphins was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; Palka *et al.* in review). Total track line length was 32,600 km. The ships covered waters between the 50 and 1000 fathom depth contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom depth contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom depth contour line. Data collection and analysis methods used were described in Palka (1996).

An abundance of 18,631 (CV=0.35) for Risso's dolphins was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900 km of track line in waters north of Maryland (38° N) (Figure 1; Palka *et al.* in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of 10,479 (CV=0.51) for Risso's dolphins was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 5,570 km of track line in waters south of Maryland (38°N) (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for Risso's dolphins is the sum of the estimates from the two 1998 USA Atlantic surveys, 29,110 (CV=0.29), where the estimate from the northern USA Atlantic is 18,631 (CV=0.35) and from the southern USA Atlantic is 10,479 (CV=0.51). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Table 1. Summary of abundance estimates for the western North Atlantic Risso's dolphin. Month, year, and area covered during each abundance survey, resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	212	0.62
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	5587	1.16
Jul-Sep 1998	Maryland to Gulf of St. Lawrence	18,631	0.35
Jul-Aug 1998	Florida to Maryland	10,479	0.51
Jul-Sep 1998	Gulf of St. Lawrence to Florida (COMBINED)	29,110	0.29

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for Risso's dolphins is 29,110 (CV=0.29). The minimum population estimate for the western North Atlantic Risso's dolphin is 22,916 (CV=0.29).

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 22,916 (CV=0.29). The maximum productivity rate is 0.04, the default value for cetaceans (Barlow *et al.* 1995). The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be ~~0.48~~ 0.40 because the CV of the average mortality estimate is ~~between 0.3–0.6~~ greater than 0.8 (Wade and Angliss 1997). PBR for the western North Atlantic Risso’s dolphin is ~~220~~ 183.

ANNUAL HUMAN-CAUSED MORTALITY

Total annual estimated average fishery-related mortality or serious injury to this stock during ~~1994–1998~~ 1995–1999 was ~~52~~ 56 Risso's dolphins (CV= ~~0.33~~ 0.89; Table 2).

Fishery Information

Prior to 1977, there was no documentation of marine mammal bycatch in distant-water fleet (DWF) activities off the northeast coast of the USA. With implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA) in that year, an observer program was established which has recorded fishery data and information of incidental bycatch of marine mammals. DWF effort in the USA Atlantic Exclusive Economic Zone (EEZ) under MFCMA has been directed primarily towards Atlantic mackerel and squid. From 1977 through 1982, an average of 120 different foreign vessels per year (range 102–161) operated within the USA Atlantic EEZ. In 1982, there were 112 different foreign vessels; 16%, or 18, were Japanese tuna longline vessels operating along the USA east coast. This was the first year that the Northeast Regional Observer Program assumed responsibility for observer coverage of the longline vessels. Between 1983 and 1991, the numbers of foreign vessels operating within USA Atlantic EEZ each year were 67, 52, 62, 33, 27, 26, 14, 13, and 9, respectively. Between 1983 and 1988, the numbers of DWF vessels included 3, 5, 7, 6, 8, and 8, respectively, Japanese longline vessels. Observer coverage on DWF vessels was 25–35% during 1977–82, and increased to 58%, 86%, 95%, and 98%, respectively, in 1983–86. From 1987–91, 100% observer coverage was maintained. Foreign fishing operations for squid and mackerel ceased at the end of the 1986 and 1991 fishing seasons, respectively. NMFS foreign-fishery observers have reported four deaths of Risso's dolphins incidental to squid and mackerel fishing activities in the continental shelf and continental slope waters between March 1977 and December 1991 (Waring *et al.* 1990; NMFS unpublished data). Three animals were taken by squid trawlers and a single animal was killed in longline fishing operations.

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, pelagic pair trawl fishery, and pelagic longline fishery, but no mortalities or serious injuries have been documented in the Northeast multispecies sink gillnet, mid-Atlantic coastal gillnet, or North Atlantic bottom trawl observed fisheries.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, 1996, and 1998 were 233, 243, 232, 197, 164, 149, and 113 respectively. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (*i.e.*, permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. ~~Since~~ From 1994–1998, between 10 and 13 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, 64% in 1996, and 99% in 1998. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into

two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fisheries information. Variances were estimated using bootstrap re-sampling techniques. Fifty one Risso's dolphin mortalities were observed between 1989 and 1998. One animal was entangled and released alive. Bycatch occurred during July, September and October along continental shelf edge canyons off the southern New England coast. Estimated annual mortality and serious injury (CV in parentheses) attributable to the drift gillnet fishery was 87 in 1989 (0.52), 144 in 1990 (0.46), 21 in 1991 (0.55), 31 in 1992 (0.27), 14 in 1993 (0.42), 1.5 in 1994 (0.16), 6 in 1995 (0), 0 in 1996, NA in 1997, 9 in 1998 (0). ~~The 1994-1998 average mortality for this fishery was 4.1 (CV=0.01) (Table 2).~~ **Since this fishery no longer exists, it has been excluded from Table 2 (see Waring *et al.* 1999).**

Pelagic Pair Trawl

Effort in the pelagic pair trawl fishery increased during the period 1989 to 1993, from zero hauls in 1989 and 1990, to an estimated 171 hauls in 1991, and then to an estimated 536 hauls in 1992, 586 in 1993, 407 in 1994, and 440 in 1995, respectively. This fishery ceased operations in 1996, when NMFS rejected a petition to consider pair trawl gear as an authorized gear type in Atlantic tunas fishery. The fishery operated from August-November in 1991, from June-November in 1992, from June-October in 1993 (Northridge 1996), and from mid-summer to November in 1994 and 1995. Sea sampling began in October 1992 (Gerritor *et al.* 1994), and 48 sets (9% of the total) were sampled in that season, 102 hauls (17% of the total) were sampled in 1993. In 1994 and 1995, 52% and 55%, respectively, of the sets were observed. Nineteen vessels have operated in this fishery. The fishery extends from 35°N to 41°N, and from 69°W to 72°W. Approximately 50% of the total effort was within a one degree square at 39°N, 72°W, around Hudson Canyon. Examination of the locations and species composition of the bycatch, showed little seasonal change for the six months of operation and did not warrant any seasonal or areal stratification of this fishery (Northridge 1996). One mortality was observed in 1992. Estimated annual fishery-related mortality (CV in parentheses) was 0.6 dolphins in 1991 (1.0), 4.3 in 1992 (0.76), 3.2 in 1993 (1.0), 0 in 1994 and 3.7 in 1995 (0.45). Since this fishery no longer exists, it has been excluded from Table 2.

During the 1994 and 1995 experimental fishing seasons, fishing gear experiments were conducted to collect data on environmental parameters, gear behavior, and gear handling practices to evaluate factors affecting catch and bycatch (Goudey 1995, 1996). Results of these studies were inconclusive in identifying factors responsible for marine mammal bycatch.

Pelagic Longline

Total effort, excluding the Gulf of Mexico, for the pelagic longline fishery, based on mandatory self-reported fisheries information, was 11,279 sets in 1991, **10311** sets in 1992, **10444** sets in 1993, **11082** sets in 1994, **11493** sets in 1995, **9864** sets in 1996, **9499** sets in 1997, **7589** sets in 1998, and **6786** sets in 1999 (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999; Yeung 1999a; Yeung *et al.* 2000). **This annual effort has been recalculated to include those sets targeting other species in conjunction with tuna/swordfish, instead of just effort that exclusively targeted tuna/swordfish as in previous reports (Johnson *et al.* 1999; Yeung 1999a). The result is an average increase in self-reported effort of roughly 10% on the average (Yeung *et al.* 2000).** The fishery has been observed from January to March off Cape Hatteras, in May and June in the entire mid-Atlantic, and in July through December in the mid-Atlantic Bight and off Nova Scotia. This fishery has been monitored **with 3-6% observer coverage**, in terms of **sets** observed, since 1992. The 1993-1997, estimated take was based on a revised analysis of the observed incidental take and self-reported incidental take and effort data, and replace previous estimates for the 1990-1993 and 1994-1995 periods (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999). Further, Yeung (1999b), revised the 1992-1997 fishery mortality estimates in Johnson *et al.* (1999) to include seriously injured animals. The 1998 **and 1999** bycatch estimates were from Yeung (1999a) **and Yeung *et al.* (2000), respectively.** Most of the estimated marine mammal bycatch was from EEZ waters between South Carolina and Cape Cod. Excluding the Gulf of Mexico, from 1992-1999, one mortality was observed 1994 **and 0 in other years, and the observed number of seriously-injured but released alive individuals from 1992-1999 was respectively 2, 0, 6, 4, 1, 0, 1, and 1** (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999; Yeung 1999a; Yeung *et al.* 2000) (Table 2). Estimated annual fishery-related mortality (CV in parentheses) was **17** in 1994 (1.0), **and 0 in other years (Table 2).**

Seriously injured and released alive animals were estimated to be 54 (0.7) in 1992, 0 in 1993, 120 (0.57) in 1994, 103 (0.68) in 1995, 99 (1.0) in 1996, 0 in 1997, 57 (1.0) in 1998, and 22 (1.0) in 1999 (Table 2).

Table 2. Summary of the incidental mortality of Risso's dolphin (*Grampus griseus*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the observed mortalities and serious injuries recorded by on-board observers, the estimated annual mortality and serious injury, the combined annual estimates of mortality and serious injury (Estimated Combined Mortality), the estimated CV of the combined estimates (Estimated CVs) and the mean of the combined estimates (CV in parentheses).

Fishery	Years	Vessels	Data Type ¹	Observer Coverage	Observed Serious Injury	Observed Mortality	Estimated Serious Injury	Estimated Mortality	Estimated Combined Mortality	Estimated CVs	Mean Annual Mortality
Pelagic Longline ²	95-99	277, 253, 245, 205, 193 ³	Obs. Data Logbook	.04, .03, .03, .03, .04	4, 1, 0, 1, 1	0, 0, 0, 0, 0	103, 99, 0, 57, 22	0, 0, 0, 0, 0	103, 99, 0, 57, 22	.68, 1.0, 0, 1.0, 1.0	56 (.89)
TOTAL											56 (.89)

¹ Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects landings data (Weighout), and total landings are used as a measure of total effort for the coastal gillnet fishery.

² 1995-1999 Mortality estimates were taken from Table 9 in Yeung et al. (NMFS Miami Laboratory PRD 99/00-13), and exclude the Gulf of Mexico.

³ Number of vessels in the fishery are based on vessels reporting effort to the pelagic longline logbook.

Other mortality

From 1995-1998, twelve Risso's dolphins stranding were recorded along the USA Atlantic coast (NMFS unpublished data). The 1999 data are under review.

In eastern Canada, one Risso's dolphin stranding was reported on Sable Island, Nova Scotia from 1970-1998 (Lucas and Hooker 2000).

STATUS OF STOCK

The status of Risso's dolphins relative to OSP in the USA Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine the population trends for this species. The total fishery mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, can not be considered to be insignificant and approaching a zero mortality and serious injury rate. The ~~1994-1998~~1995-1999 average annual fishery-related mortality does not exceed PBR; therefore, this is not a strategic stock.

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LONG-FINNED PILOT WHALE (*Globicephala melas*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

There are two species of pilot whales in the Western Atlantic — the Atlantic or long-finned pilot whale, *Globicephala melas*, and the short-finned pilot whale, *G. macrorhynchus*. These species are difficult to identify to the species level at sea; therefore, some of the descriptive material below refers to *Globicephala* sp., and is identified as such. The species boundary is considered to be in the New Jersey to Cape Hatteras area. Sightings north of this area are likely *G. melas*.

Pilot whales (*Globicephala* sp.) are distributed principally along the continental shelf edge in the winter and early spring off the northeast USA coast, (CETAP 1982; Payne and Heinemann 1993). In late spring, pilot whales move onto Georges Bank and into the Gulf of Maine and more northern waters, and remain in these areas through late autumn (CETAP 1982; Payne and Heinemann 1993). In general, pilot whales generally occupy areas of high relief or submerged banks. They are also associated with the Gulf Stream north wall and thermal fronts along the continental shelf edge (Waring *et al.* 1992; NMFS unpublished data).

The long-finned pilot whale is distributed from North Carolina to Iceland and possibly the Baltic Sea (Sergeant 1962; Leatherwood *et al.* 1976; Abend 1993). The stock structure of the North Atlantic population is currently unknown (Anon. 1993a); however, several recently initiated genetic studies and proposed North Atlantic sighting surveys will likely provide information required to delineate stock boundaries.

POPULATION SIZE

The total number of long-finned pilot whales off the eastern USA and Canadian Atlantic coast is unknown, although ten estimates from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). Two estimates were derived from catch data and population models that estimated the abundance of the entire stock. Seven seasonal estimates are available from selected regions in USA waters during spring, summer and autumn 1978-82, August 1990, June-July 1991, August-September 1991, June-July 1993, July-September 1995, and July-August 1998. Because long-finned and short-finned pilot whales are difficult to identify at sea, seasonal abundance estimates were reported for *Globicephala* sp., both long-finned and short-finned pilot whales. One estimate is available from the Gulf of St. Lawrence.

Mitchell (1974) used cumulative catch data from the 1951-61 drive fishery off Newfoundland to estimate the initial population size (ca. 50,000 animals).

Mercer (1975), used population models to estimate a population in the same region of between 43,000-96,000 long-finned pilot whales, with a range of 50,000-60,000 being considered the best estimate.

An abundance of 11,120 (CV=0.29)

Globicephala sp. was estimated from an aerial survey program conducted from 1978 to 1982 on the continental, shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP

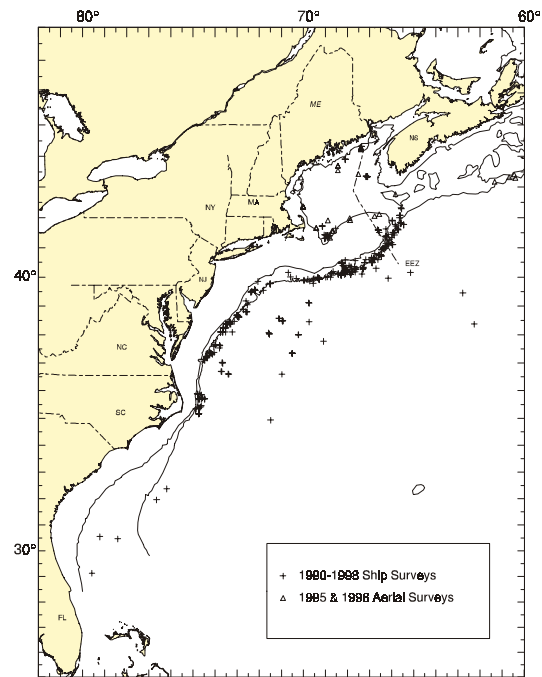


Figure 1. Distribution of pilot whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and 1,000 m.

1982). An abundance of 3,636 (CV=0.36) *Globicephala* sp. was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Waring *et al.* 1992; Waring 1998). An abundance of 3,368 (CV=0.28) and 5,377 (CV=0.53) *Globicephala* sp. was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Anon. 1991). As recommended in the GAMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of 668 (CV=0.55) *Globicephala* sp. was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993b). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school-size bias, if applicable, but do not include corrections for $g(0)$ or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 8,176 (CV=0.65) *Globicephala* sp. was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; Palka *et al.* in review). Total track line length was 32,600 km. The ships covered waters between the 50 and 1000 fathom depth contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom depth contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom depth contour line. Data collection and analysis methods used were described in Palka (1996).

Kingsley and Reeves (1998), obtained an abundance estimate of 1,600 long-finned pilot whales (CV=0.65) from a late August and early September 1995 aerial survey of cetaceans in the Gulf of St. Lawrence in 1995 and 1998 (Table 1). Based on an examination of long-finned pilot whale summer distribution patterns, and information on stock structure it was deemed appropriate to combine these estimates with NMFS 1995 summer survey data. The best 1995 abundance estimate for *Globicephala* sp. is the sum of the estimates from the USA and Canadian surveys, 9,776 (CV=0.55), where the estimate from the USA survey is 8,176 (CV=0.65) and from the Canadian 1,600 (CV=0.65).

An abundance of 9,800 (CV=0.34) for *Globicephala* sp. was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900 km of track line in waters north of Maryland (38° N) (Figure 1; Palka *et al.* in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of 4,724 (CV=0.61) for *Globicephala* sp. was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 5,570 km of track line in waters south of Maryland (38°N) (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for *Globicephala* sp. is the sum of the estimates from the two 1998 USA Atlantic surveys, 14,524 (CV=0.30), where the estimate from the northern USA Atlantic is 9,800 (CV=0.34) and from the southern USA Atlantic is 4,724 (CV=0.61). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Table 1. Summary of abundance estimates for the western North Atlantic *Globicephala* sp. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	668	0.55
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	8,176	0.65
Aug-Sep 1995	Gulf of St. Lawrence	1,600	0.65
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	9,776	0.55
Jul-Sep 1998	Maryland to Gulf of St. Lawrence	9,800	0.34
Jul-Aug 1998	Florida to Maryland	4,724	0.61
Jul-Sep 1998	Gulf of St. Lawrence to Florida (COMBINED)	14,524	0.30

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for *Globicephala* sp. is 14,524 (CV=0.30). The minimum population estimate for *Globicephala* sp. is 11,343 (CV=0.30).

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include those from animals taken in the Newfoundland drive fishery: calving interval 3.3 years; lactation period about 21-22 months; gestation period 12 months; births mainly from June to November; length at birth is 177 cm; mean length at sexual maturity, 490 cm, males; and 356 cm, females; age at sexual maturity is 12 years for males and 6 years for females, and mean adult length is 557 cm for males and 448 cm for females; and maximum age was 40 for males, and 50 for females (Sergeant 1962; Kasuya *et al.* 1988). Analysis of data recently collected from animals taken in the Faroe Islands drive fishery produced higher values for all parameters (Bloch *et al.* 1993; Desportes *et al.* 1993; Martin and Rothery 1993). These differences are likely related, at least in part, to larger sample sizes and newer analytical techniques.

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for *Globicephala* sp. is 11,343 (CV=0.30). The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be ~~0.5~~ 0.48 because the CV of the average mortality estimate is ~~less than 0.3~~ between 0.3-0.6 (Wade and Angliss 1997), and because this stock is of unknown status. PBR for the western North Atlantic *Globicephala* sp. is ~~113~~ 108.

ANNUAL HUMAN-CAUSED MORTALITY

Total fishery-related mortality and serious injury cannot be estimated separately for the two species of pilot whales in the USA Atlantic EEZ because of the uncertainty in species identification by fishery observers. The Atlantic Scientific Review Group advised adopting the risk-averse strategy of assuming that either species might have been subject to the observed fishery-related mortality and serious injury. Total annual estimated average fishery-related mortality or serious injury to this stock during ~~1994-1998~~ 1995-1999 in the USA fisheries listed below was ~~137 (CV=0.22)~~ 237 pilot whales (CV = 0.44) (Table 2). The Canadian average annual mortality estimate for ~~1994 to 1996~~ 1995-1996 from the Nova Scotia trawl fisheries is 98 long-finned pilot whales. It is not possible to estimate variance of the Canadian estimate. The total average annual mortality estimate for ~~1994 to 1998~~ 1995-1999 from the USA and Nova Scotia trawl fisheries is ~~146~~ 245 (Table 2).

Fishery Information

USA

Prior to 1977, there was no documentation of marine mammal bycatch in distant-water fleet (DWF) activities off the northeast coast of the USA. A fishery observer program, which has collected fishery data and information on incidental bycatch of marine mammals, was established in 1977 with the implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA). DWF effort in the Atlantic coast EEZ under MFCMA has been directed primarily towards Atlantic mackerel and squid. An average of 120 different foreign vessels per year (range 102-161) operated within the Atlantic coast EEZ during 1977 through 1982. In 1982, there were 112 different foreign vessels; 18 (16%) were Japanese tuna longline vessels operating along the USA Atlantic coast. This was the first year that the Northeast Regional Observer Program assumed responsibility for observer coverage of the longline vessels. The number of foreign vessels operating within the USA Atlantic EEZ each year between 1983 and 1991 averaged 33 and ranged from nine to 67. The number of Japanese longline vessels included among the DWF vessels averaged six and ranged from three to eight between 1983 and 1988. MFCMA observer coverage on DWF vessels was 25-35% during 1977-82, increased to 58%, 86%, 95%, and 98%, respectively, during 1983-86, and 100% observer coverage was maintained from 1987-91. Foreign fishing operations for squid ceased at the end of the 1986 fishing season and, for mackerel, at the end of the 1991 fishing season.

During 1977-1991, observers in this program recorded 436 pilot whale mortalities in foreign-fishing activities (Waring *et al.* 1990; Waring 1995). A total of 391 (90%) were taken in the mackerel fishery, and 41 (9%) occurred during *Loligo* and *Illex* squid-fishing operations. This total includes 48 documented takes by USA vessels involved in joint venture fishing operations in which USA captains transfer their catches to foreign processing vessels. Due to temporal fishing restrictions, the bycatch occurred during winter/spring (December to May) in continental shelf and continental shelf edge waters (Fairfield *et al.* 1993; Waring 1995); however, the majority of the takes occurred in late spring along the 100 m isobath. Two animals were also caught in both the hake fishery and tuna longline fisheries (Waring *et al.* 1990).

The distribution of long-finned pilot whale, a northern species, overlaps with that of the short-finned pilot whale, a predominantly southern species, between 35°30'N to 38°00'N (Leatherwood *et al.* 1976). Although long-finned pilot whales are most likely taken in the waters north of Delaware Bay, many of the pilot whale takes are not identified to species and bycatch does occur in the overlap area. In this summary, therefore, long-finned pilot whales (*Globicephala melas*) and unidentified pilot whales (*Globicephala* sp.) are considered together.

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet, pelagic longline, and pelagic pair trawl fisheries, but no mortalities or serious injuries have documented in the Northeast multispecies sink gillnet or mid-Atlantic coastal gillnet.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, 1996, and 1998 were 233, 243, 232, 197, 164, 149, and 113 respectively. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (*i.e.*, permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. ~~Since~~ **From 1994 to 1998**, between 10 and 13 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, 64% in 1996, 1997 (NA), and 99% in 1998. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fisheries information. Variances were estimated using bootstrap re-sampling techniques. Between 1989 and 1998, eighty-seven mortalities were observed in the large pelagic drift gillnet fishery. The annual fishery-related mortality (CV in parentheses) was 77 in 1989 (0.24), 132 in 1990 (0.24), 30 in 1991 (0.26), 33 in 1992 (0.16), 31 in 1993 (0.19), 20 in 1994 (0.06), 9.1 in 1995 (0), 11 in 1996 (.17), 1997 (NA), and 12 in 1998 (0). ~~average annual mortality between 1994-1998 was 13 pilot whales (0.04) (Table 2).~~ **Since this fishery no longer exists it has been excluded from Table 2.** Pilot whales were taken along the continental shelf edge, northeast of Cape Hatteras in January and February. Takes were recorded at the continental shelf edge east of Cape Charles, Virginia, in June. Pilot whales were taken from Hydrographer Canyon along the Great South Channel to Georges Bank from July-November. Takes occurred at the Oceanographer Canyon continental shelf break and along the continental shelf northeast of Cape Hatteras in October-November.

Pelagic Pair Trawl

Effort in the pelagic pair trawl fishery has increased during the period 1989 to 1993, from zero hauls in 1989 and 1990, to an estimated 171 hauls in 1991, and then to an estimated 536 hauls in 1992, 586 in 1993, 407 in 1994, and 440 in 1995, respectively. This fishery ceased operations in 1996, when NMFS rejected a petition to consider pair trawl gear as an authorized gear type in Atlantic tunas fishery. The fishery operated from August-November in 1991, from June-November in 1992, from June-October in 1993, and from mid-summer to November in 1994 and 1995. Sea sampling began in October 1992 (Gerrior *et al.* 1994), and 48 sets (9% of the total) were sampled in that season, 102 hauls (17% of the total) were sampled in 1993. In 1994 and 1995, 52% (212) and 54% (238), respectively, of the sets were observed. Twelve vessels have operated in this fishery. The fishery extends from 35°N to 41°N, and from 69°W to 72°W. Approximately 50% of the total effort was within a one degree square at 39°N, 72°W, around Hudson Canyon. Examination of the locations and species composition of the bycatch, showed little seasonal change for the six months of operation and did not warrant any seasonal or areal stratification of this fishery (Northridge 1996). Five pilot whale (*Globicephala* sp.) mortalities were reported in the self-reported fisheries information in 1993. In 1994 and 1995 observers reported one and twelve mortalities, respectively. The estimated fishery-related mortality to pilot whales in the USA Atlantic attributable to this fishery in 1994 was 2.0 (CV=0.49) and 22 (CV=0.33) in 1995. **Since this fishery no longer exists, it has been excluded from Table 2.**

During the 1994 and 1995 experimental fishing seasons, fishing gear experiments were conducted to collect data on environmental parameters, gear behavior, and gear handling practices to evaluate factors affecting catch and bycatch (Goudey 1995, 1996). Results of these studies were inconclusive in identifying factors responsible for marine mammal bycatch.

Pelagic Longline

Total effort, excluding the Gulf of Mexico, for the pelagic longline fishery, based on mandatory self-reported fisheries information, was 11,279 sets in 1991, **10311** sets in 1992, **10444** sets in 1993, **11082** sets in 1994, **11493** sets in 1995, **9864** sets in 1996, **9499** sets in 1997, **7589** sets in 1998, and **6786** sets in 1999 (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999; Yeung 1999a; **Yeung *et al.* 2000**). **This annual effort has been recalculated to include those sets targeting other species in conjunction with tuna/swordfish, instead of just effort that**

exclusively targeted tuna/swordfish as in previous reports (Johnson *et al.* 1999; Yeung 1999a). The result is an average increase in self-reported effort of roughly 10% on the average (Yeung *et al.* 2000). The fishery has been observed from January to March off Cape Hatteras, in May and June in the entire mid-Atlantic, and in July through December in the mid-Atlantic Bight and off Nova Scotia. This fishery has been monitored with 3-6% observer coverage, in terms of sets observed, since 1992. The 1993-1997, estimated take was based on a revised analysis of the observed incidental take and self-reported incidental take and effort data, and replace previous estimates for the 1990-1993 and 1994-1995 periods (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999). Further, Yeung (1999b), revised the 1992-1997 fishery mortality estimates in Johnson *et al.* (1999) to include seriously injured animals. The 1998 and 1999 bycatch estimates were from Yeung (1999a) and Yeung *et al.* (2000), respectively. Most of the estimated marine mammal bycatch was from EEZ waters between South Carolina and Cape Cod (Johnson *et al.* 1999). Pilot whales are frequently observed to feed on hooked fish, particularly big-eye tuna (NMFS unpublished data). Between 1992-1999 sixty-two pilot whales (including two identified as a short-finned pilot whales) were released alive, including 32 that were considered seriously injured (of which one was identified as a short-finned pilot whale), and two mortalities were observed. January-March bycatch was concentrated on the continental shelf edge northeast of Cape Hatteras. Bycatch was recorded in this area during April-June, and takes also occurred north of Hydrographer Canyon off the continental shelf in water over 1,000 fathoms during April-June. During the July-September period, takes occurred on the continental shelf edge east of Cape Charles, Virginia, and on Block Canyon slope in over 1,000 fathoms of water. October-December bycatch occurred along the 20 to 50 fathom contour lines between Barnegatt Bay and Cape Hatteras. The estimated fishery-related mortality to pilot whales in the US Atlantic (excluding the Gulf of Mexico) attributable to this fishery was: 127 in 1992 (CV=1.00) and 93 in 1999 (CV=1.00). The estimated serious injuries were 40 (CV=0.71) in 1992, 19 (CV=1.00) in 1993, 232 (CV=0.53) in 1994, 345 (CV= 0.51) in 1995, 0 from 1996 to 1998, and 288 (CV=0.74) in 1999, (includes 37 estimated short-finned pilot whales) in 1995 (CV=1.00); average annual mortality between 1995 and 1999 was 145 pilot whales (0.66) (Table 2). Seriously injured and released alive animals are combined with mortalities in the category 'combined mortality'.

Bluefin Tuna Purse Seine

The tuna purse seine fishery between Cape Hatteras and Cape Cod is directed at small and medium bluefin and skip jack for the canning industry, while north of Cape Cod purse seine vessels are directed at large medium and giant bluefin tuna (NMFS, 1995). The latter fishery is entirely separate from any other Atlantic tuna purse seine fishery. Spotter aircraft are used to locate fish schools. The official start date is August 15, set by regulation. Individual vessel quotas (IVQs) and a limited access system prevent a derby fishery situation. Catch rates are high with this gear and consequently, the season usually only lasts a few weeks for large mediums and giants. The 1996 regulations allocated 250 MT (5 IVQs) with a minimum of 90% giants and 10% large mediums. Limited observer data are available for the bluefin tuna purse seine fishery. Out of 45 total trips made in 1996, 43 trips (95.6%) were observed. Forty-four sets were made on the 43 observed trips and all sets were observed. A total of 136 days were covered. Two interactions with pilot whales were observed in 1996. In one interaction, the net was actually pursed around one pilot whale, the rings were released and the animal escaped alive, condition unknown. This set occurred east of the Great South Channel and just north of the Cultivator Shoals region on Georges Bank. In a second interaction, five pilot whales were encircled in a set. The net was opened prior to pursuing to let the whales swim free, apparently uninjured. This set occurred on the Cultivator Shoals region on Georges Bank. Since 1996, this fishery was has not been observed. in 1997 and 1998

North Atlantic Bottom Trawl

Vessels in the North Atlantic bottom trawl fishery, a Category III fishery under the MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. An average of 970 (CV= 0.04) vessels (full and part time) participated annually in the fishery during 1989-1993. The fishery is active in New England in all seasons. One mortality was documented in 1990, and one animal was released alive and uninjured in 1993. The estimated fishery-related mortality to pilot whales in the USA Atlantic attributable to this fishery was: 0 in 1994-1998, and 228 in 1999. The average annual mortality between 1994 and 1998 1995-1999 was 046 pilot whales (CV = 1.03) (Table 2). However, these estimates should be viewed with caution due to the extremely low (<1%) observer coverage.

Squid, Mackerel, Butterfish Trawl

The mid-Atlantic mackerel and squid trawl fisheries were combined into the Atlantic mid-water trawl fishery in the revised proposed list of fisheries in 1995. The fishery occurs along the USA mid-Atlantic continental shelf region between New Brunswick, Canada, and Cape Hatteras year around. The mackerel trawl fishery was classified as a Category II fishery since 1990 and the squid fishery was originally classified as a Category II fishery in 1990, but was reclassified as a Category III fishery in 1992. The combined fishery was reclassified as a Category II fishery in 1995. In 1996, mackerel, squid, and butterfish trawl fisheries were combined into the Atlantic squid, mackerel, butterfish trawl fishery, and maintained a Category II classification. Three fishery-related mortality of pilot whales were reported in self-reported fisheries information from the mackerel trawl fishery between 1990-1992. One mortality was observed in the years 1996, and 1998 and, 1999. The 1996 and 1998 bycatch both occurred in the *Illex* squid fishery, and the 1999 in the *Loligo* fishery. The estimated fishery-related mortality to pilot whales in the USA Atlantic attributable to this fishery was: 45 in 1996 (CV = 1.27), 0 in 1997, and 85 in 1998 (CV = 0.65), and 49 in 1999 (CV = 0.97); average annual mortality between 1996 and 1999 was 43.45 pilot whales (CV=0.61) (Table 2). However, these estimates should be viewed with caution due to the extremely low (<1%) observer coverage.

Mid-Atlantic Coastal Gillnet

Observer coverage of the USA Atlantic coastal gillnet fishery was initiated by the NEFSC Sea Sampling program in July, 1993; and from July to December 1993, 20 trips were observed. During 1994 and 1995 221 and 382 trips were observed, respectively. This fishery, which extends from North Carolina to New York, is actually a combination of small vessel fisheries that target a variety of fish species, some of which operate right off the beach. The number of vessels in this fishery is unknown, because records which are held by both state and federal agencies have not been centralized and standardized. Observer coverage, expressed as percent of tons of fish landed, was 5% 4%, 3%, and 5% for 1995, 1996, 1997, and 1998 (Table 2).

No pilot whales were taken in observed trips during 1993-1997. One pilot whale was observed taken in 1998, and 0 in 1999 (Table 2). Observed effort was concentrated off NJ and scattered between DE and NC from 1 to 50 miles off the beach. All bycatches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 7 in 1998 (1.1). Average annual estimated fishery-related mortality attributable to this fishery during 1995-1999 was 2.1 pilot whale (CV=1.1)

CANADA

An unknown number of pilot whales have also been taken in Newfoundland and Labrador, and Bay of Fundy, groundfish gillnets, Atlantic Canada and Greenland salmon gillnets, and Atlantic Canada cod traps (Read 1994). The Atlantic Canadian and Greenland salmon gillnet fishery is seasonal, with the peak from June to September, depending on location. In southern and eastern Newfoundland, and Labrador during 1989, 2,196 nets 91 m long were used. There are no effort data available for the Greenland fishery; however, the fishery was terminated in 1993 under an agreement between Canada and North Atlantic Salmon Fund (Read 1994).

There were 3,121 cod traps operating in Newfoundland and Labrador during 1979, and about 7,500 in 1980 (Read 1994). This fishery was closed at the end of 1993 due to collapse of Canadian groundfish resources.

Between January 1993 and December 1994, 36 Spanish deep-water trawlers, covering 74 fishing trips (4,726 fishing days and 14,211 sets), were observed in NAFO Fishing Area 3 (off the Grand Bank) (Lens 1997). A total of 47 incidental catches were recorded, which included one long-finned pilot whale. The incidental mortality rate for pilot whales was 0.007/set.

In Canada, the fisheries observer program places observers on all foreign fishing vessels, on between 25-40% of large Canadian vessels (greater than 100 ft), and on approximately 5% of small vessels (Hooker *et al.* 1997). Fishery observer effort off the coast of Nova Scotia during 1991-1996 varied on a seasonal and annual basis, reflecting changes in fishing effort (see Figure 3, Hooker *et al.* 1997). During the 1991-96 period, long-finned pilot whales were bycaught (number of animals in parentheses) in bottom trawl (65); midwater trawl (6); and longline (1) gear. Recorded bycatches by year were: 16 in 1991, 21 in 1992, 13 in 1994, 9 in 1995, and 6 in 1996. Pilot whale bycatches occurred in all months except January-March and September (Hooker *et al.* 1997).

Table 2. Summary of the incidental mortality of pilot whales (*Globicephala sp.*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the observed mortalities and serious injuries recorded by on-

board observers , the estimated annual mortality and serious injury, the combined annual estimates of mortality and serious injury (Estimated Combined Mortality), the estimated CV of the combined estimates (Estimated CVs) and the mean of the combined estimates (CV in parentheses).

Fishery	Years	Vessels	Data Type ¹	Observer Coverage ²	Observed Serious Injury	Observed Mortality	Estimated Serious Injury	Estimated Mortality	Estimated Combined Mortality	Estimated CVs	Mean Annual Mortality
Atlantic ⁵ squid, mackerel, butterfish trawl	96-99	NA	Obs. Data Weighouts	.007, .008, .003, .004	0, 0, 0, 0	6, 0, 1, 1		45, 0, 85, 49		1.27, 0, .65, .97	45 (.52)
N. Atl. ^{3,5} Bottom Trawl	95-99	NA	Obs. Data Weighouts	.011 ⁴ , .002, .002, .001, .003	0, 0, 0, 0, 0	0, 0, 0, 0, 1		0, 0, 0, 0, 228		, 0, 0, 0, 0, 1.03	46 (1.03)
Pelagic ⁶ Longline	95-99	277, 253, 245, 205, 193 ⁷	Obs. Data Logbook	.04, .03, .03, .03, .04	13, 0, 0, 0, 4	0, 0, 0, 0, 1	345, 0, 0, 0, 288	0, 0, 0, 0, 93	345, 0, 0, 0, 381	0.51, 0, 0, 0, 0.79	145 (0.66)
Mid-Atlantic Coastal Gillnet	95-99	NA	Obs. Data Weighouts	.05, .04, .03, .05, .02	0, 0, 0, 0, 0	0, 0, 0, 1, 0		0, 0, 0, 7, 0		0, 0, 0, 1.1, 0	1 (1.1)
Nova Scotia trawl fisheries	95-96	NA	Obs. Data	NA, NA	0, 0, 0, 0	9, 6		9, 6		NA, NA	8 (NA)
TOTAL											245 (0.44)

¹ Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook data were used to measure total effort for the longline fishery . These data are collected at the Southeast Fisheries Science Center (SEFSC).

² Observer coverage of the mid-Atlantic coastal gillnet fishery is measured in tons of fish landed. Observer coverage for the longline fishery are in terms of sets. The trawl fisheries are measured in trips.

³ 1995 estimate not available for the squid, mackerel and butterfish subfisheries.

⁴ Observer coverage for the Atlantic bottom trawl fishery in 1995 is based on only January to May data.

⁵ In 1997 and 1998 the observed pilot whales were taken from the *Illlex* squid otter trawl subfishery. The 1999 observed pilot whales were taken from the *Loligo* squid and N. Atlantic otter trawl subfisheries.

⁶ 1995-1999 Mortality estimates were taken from Table 9a in Yeung et al. (NMFS Miami Laboratory PRD 99/00-13), and exclude the Gulf of Mexico.

⁷ Number of vessels in the fishery are based on vessels reporting effort to the pelagic longline logbook.

Other Mortality

Pilot whales have a propensity to mass strand throughout their range, but the role of human activity in these events is unknown. Between two and 120 pilot whales have stranded annually either individually or in groups in NMFS Northeast Region (Anon. 1993b) since 1980. From 1992-1998, 71 long-finned pilot whale stranded between South Carolina and Maine, including 22 animals that mass stranded in 1992 along the Massachusetts coast (NMFS unpublished data).

In eastern Canada, six dead 37 strandings of long-finned pilot whales (173 individuals) were reported on Sable Island, Nova Scotia from 1990-1996 1970-1998 (Lucas and Hooker 1997; Lucas and Hooker 2000). This included 130 animals that mass stranded in December 1976, and two smaller groups (<10 each) in autumn 1979 and

summer 1992. Fourteen strandings were also recorded along Nova Scotia from 1991-1996 (Hooker *et al.* 1997; Lucas and Hooker 1997).

A potential human-caused source of mortality is from polychlorinated biphenyls (PCBs) and chlorinated pesticides (DDT, DDE, dieldrin, etc.) moderate levels of which have been found in pilot whale blubber (Taruski 1975; Muir *et al.* 1988; Weisbrod *et al.* 2000). Weisbrod *et al.* (2000), reported that bioaccumulation levels were more similar in whales from the same standing group than animals of the same sex or age. Also, high levels of toxic metals (mercury, lead, cadmium) and selenium were measured in pilot whales harvested in the Faroe Island drive fishery (Nielsen *et al.* 2000). The population effect of the observed levels of such contaminants is unknown.

STATUS OF STOCK

The status of long-finned pilot whales relative to OSP in USA Atlantic EEZ is unknown, but stock abundance may have been affected by reduction in foreign fishing, curtailment of the Newfoundland drive fishery for pilot whales in 1971, and increased abundance of herring, mackerel, and squid stocks. There are insufficient data to determine the population trends for this species. The species is not listed under the Endangered Species Act. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because the ~~1994-1998~~ 1995-1999 estimated average annual fishery-related mortality, excluding Nova Scotia bycatches to pilot whales, *Globicephala* sp., exceeds PBR.

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SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

There are two species of pilot whales in the Western Atlantic: the Atlantic or long-finned pilot whale, *Globicephala melas*, and the short-finned pilot whale, *G. macrorhynchus*. These species are difficult to identify to the species level at sea; therefore, some of the descriptive material below refers to *Globicephala* sp. and is identified as such. The species boundary is considered to be in the New Jersey to Cape Hatteras area. Sightings north of this area are likely *G. melas*. The short-finned pilot whale is distributed worldwide in tropical to warm temperate waters (Leatherwood and Reeves 1983). The northern extent of the range of this species within the USA Atlantic Exclusive Economic Zone (EEZ) is generally thought to be Cape Hatteras, North Carolina (Leatherwood and Reeves 1983). Sightings of these animals in USA Atlantic EEZ occur primarily within the Gulf Stream [Southeast Fisheries Science Center (SEFSC) unpublished data], and primarily along the continental shelf and continental slope in the northern Gulf of Mexico (Mullin *et al.* 1991; SEFSC unpublished data). There is no information on stock differentiation for the Atlantic population.

POPULATION SIZE

An abundance of 9,800 (CV=0.34) for *Globicephala* sp. was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900 km of track line in waters north of Maryland (38° N) (Figure 1; Palka *et al.* in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of 4,724 (CV=0.61) for *Globicephala* sp. was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 5,570 km of track line in waters south of Maryland (38°N) (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for *Globicephala* sp. is the sum of the estimates from the two 1998 USA Atlantic surveys, 14,524 (CV=0.30), where the estimate from the northern USA Atlantic is 9,800 (CV=0.34) and from the southern USA Atlantic is 4,724 (CV=0.61). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution

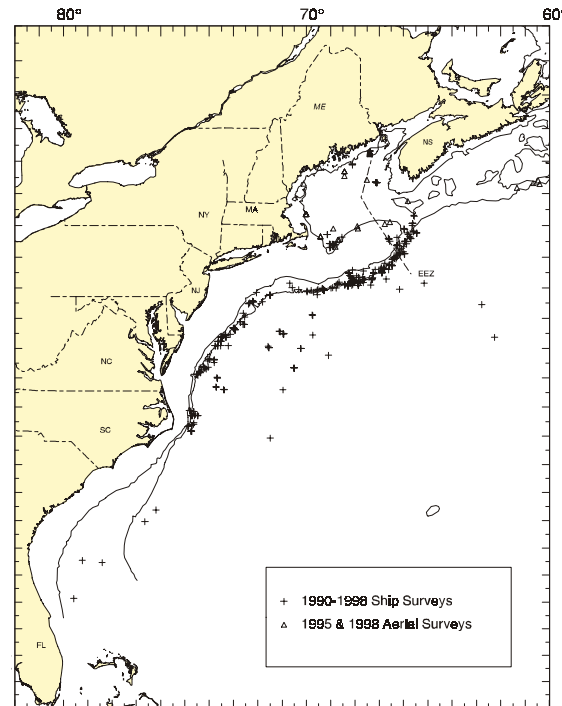


Figure 1. Distribution of pilot whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and 1,000 m.

as specified by Wade and Angliss (1997). The best estimate of abundance for *Globicephala* sp. is 14,524 (CV=0.30). The minimum population estimate for *Globicephala* sp. is 11,343.

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for *Globicephala* sp. is 11,343 (CV=0.30). The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be ~~0.5~~ 0.48 because the CV of the average mortality estimate is ~~less than 0.3~~ between 0.3-0.6 (Wade and Angliss 1997), and because this stock is of unknown status. PBR for the western North Atlantic *Globicephala* sp. is ~~113~~ 108.

ANNUAL HUMAN-CAUSED MORTALITY

Total fishery-related mortality and serious injury cannot be estimated separately for the two species of pilot whales in the USA Atlantic EEZ because of the uncertainty in species identification by fishery observers. The Atlantic Scientific Review Group advised adopting the risk-averse strategy of assuming that either species might have been subject to the observed fishery-related mortality and serious injury. Total annual estimated average fishery-related mortality or serious injury to this stock during ~~1994-1998~~ 1995-1999 in the USA fisheries listed below was ~~137 (CV=0.22)~~ 237 pilot whales (CV = 0.44) (Table 2). The Canadian average annual mortality estimate for ~~1994 to 1996~~ 1995-1996 from the Nova Scotia trawl fisheries is 98 long-finned pilot whales. It is not possible to estimate variance of the Canadian estimate. The total average annual mortality estimate for ~~1994 to 1998~~ 1995-1999 from the USA and Nova Scotia trawl fisheries is ~~146~~ 245 (Table 2).

Fishery Information

USA

The level of past or current, direct, human-caused mortality of short-finned pilot whales in the USA Atlantic EEZ is unknown. The short-finned pilot whale has been taken in the pelagic longline fishery in Atlantic waters off the southeastern USA (Lee *et al.* 1994; SEFSC unpublished data).

Prior to 1977, there was no documentation of marine mammal bycatch in distant-water fleet (DWF) activities off the northeast coast of the USA. A fishery observer program, which has collected fishery data and information on incidental bycatch of marine mammals, was established in 1977 with the implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA). DWF effort in the Atlantic coast EEZ under MFCMA has been directed primarily towards Atlantic mackerel and squid. An average of 120 different foreign vessels per year (range 102-161) operated within the Atlantic coast EEZ during 1977 through 1982. In 1982, there were 112 different foreign vessels; 18 (16%) were Japanese tuna longline vessels operating along the USA Atlantic coast. This was the first year that the Northeast Regional Observer Program assumed responsibility for observer coverage of the longline vessels. The number of foreign vessels operating within the USA Atlantic EEZ each year between 1983 and 1991 averaged 33 and ranged from nine to 67. The number of Japanese longline vessels included among the DWF vessels averaged six and ranged from three to eight between 1983 and 1988. MFCMA observer coverage on DWF vessels was 25-35% during 1977-82, increased to 58%, 86%, 95%, and 98%, respectively, during 1983-86, and 100% observer coverage was maintained from 1987-91. Foreign fishing operations for squid ceased at the end of the 1986 fishing season and, for mackerel, at the end of the 1991 fishing season.

During 1977-1991, observers in this program recorded 436 pilot whale mortalities in foreign-fishing activities (Waring *et al.* 1990; Waring 1995). A total of 391 (90%) were taken in the mackerel fishery, and 41 (9%) occurred during *Loligo* and *Illex* squid-fishing operations. This total includes 48 documented takes by USA vessels involved in joint venture fishing operations in which USA captains transfer their catches to foreign processing vessels. Due to temporal fishing restrictions, the bycatch occurred during winter/spring (December to May) in continental shelf and continental shelf edge waters (Fairfield *et al.* 1993; Waring 1995); however, the majority of the takes occurred in late spring along the 100 m isobath. Two animals were also caught in both the hake fishery and tuna longline fisheries (Waring *et al.* 1990).

The distribution of long-finned pilot whale, a northern species, overlaps with that of the short-finned pilot whale, a predominantly southern species, between 35°30'N to 38°00'N (Leatherwood *et al.* 1976). Although long-finned pilot whales are most likely taken in the waters north of Delaware Bay, many of the pilot whale takes are not identified to species and bycatch does occur in the overlap area. In this summary, therefore, long-finned pilot whales (*Globicephala melas*) and unidentified pilot whales (*Globicephala* sp.) are considered together.

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet, pelagic longline, and pelagic pair trawl fisheries, but no mortalities or serious injuries have documented in the Northeast multispecies sink gillnet or mid-Atlantic coastal sink gillnet.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, 1996, and 1998 were 233, 243, 232, 197, 164, 149, and 113 respectively. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (*i.e.*, permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. ~~Since From 1994 to 1998, between 10 and 13 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, 64% in 1996, 1997 (NA), and 99% in 1998. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fisheries information. Variances were estimated using bootstrap re-sampling techniques. Between 1989 and 1998, eighty-seven mortalities were observed in the large pelagic drift gillnet fishery. The annual fishery-related mortality (CV in parentheses) was 77 in 1989 (0.24), 132 in 1990 (0.24), 30 in 1991 (0.26), 33 in 1992 (0.16), 31 in 1993 (0.19), 20 in 1994 (0.06), 9.1 in 1995 (0), 11 in 1996 (.17), 1997 (NA), and 12 in 1998 (0).; average annual mortality between 1994-1998 was 13 pilot whales (0.04) (Table 2).~~ **Since this fishery no longer exists it has been excluded from Table 2.** Pilot whales were taken along the continental shelf edge, northeast of Cape Hatteras in January and February. Takes were recorded at the continental shelf edge east of Cape Charles, Virginia, in June. Pilot whales were taken from Hydrographer Canyon along the Great South Channel to Georges Bank from July-November. Takes occurred at the Oceanographer Canyon continental shelf break and along the continental shelf northeast of Cape Hatteras in October-November.

Pelagic Pair Trawl

Effort in the pelagic pair trawl fishery has increased during the period 1989 to 1993, from zero hauls in 1989 and 1990, to an estimated 171 hauls in 1991, and then to an estimated 536 hauls in 1992, 586 in 1993, 407 in 1994, and 440 in 1995, respectively. This fishery ceased operations in 1996, when NMFS rejected a petition to

consider pair trawl gear as an authorized gear type in Atlantic tunas fishery. The fishery operated from August-November in 1991, from June-November in 1992, from June-October in 1993, and from mid-summer to November in 1994 and 1995. Sea sampling began in October 1992 (Gerrior *et al.* 1994), and 48 sets (9% of the total) were sampled in that season, 102 hauls (17% of the total) were sampled in 1993. In 1994 and 1995, 52% and 54%, respectively, of the sets were observed. Twelve vessels have operated in this fishery. The fishery extends from 35°N to 41°N, and from 69°W to 72°W. Approximately 50% of the total effort was within a one degree square at 39°N, 72°W, around Hudson Canyon. Examination of the locations and species composition of the bycatch, showed little seasonal change for the six months of operation and did not warrant any seasonal or areal stratification of this fishery (Northridge 1996). Five pilot whale (*Globicephala* sp.) mortalities were reported in the self-reported fisheries information in 1993. In 1994 and 1995 observers reported one and twelve mortalities, respectively. Since this fishery no longer exists, it has been excluded from Tables 2 and 3.

During the 1994 and 1995 experimental fishing seasons, fishing gear experiments were conducted to collect data on environmental parameters, gear behavior, and gear handling practices to evaluate factors affecting catch and bycatch (Goudey 1995, 1996). Results of these studies were inconclusive in identifying factors responsible for marine mammal bycatch.

Pelagic Longline

Total effort, excluding the Gulf of Mexico, for the pelagic longline fishery, based on mandatory self-reported fisheries information, was 11,279 sets in 1991, 10311 sets in 1992, 10444 sets in 1993, 11082 sets in 1994, 11493 sets in 1995, 9864 sets in 1996, 9499 sets in 1997, 7589 sets in 1998, and 6786 sets in 1999 (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999; Yeung 1999a; Yeung *et al.* 2000). This annual effort has been recalculated to include those sets targeting other species in conjunction with tuna/swordfish, instead of just effort that exclusively targeted tuna/swordfish as in previous reports (Johnson *et al.* 1999; Yeung 1999a). The result is an average increase in self-reported effort of roughly 10% on the average (Yeung *et al.* 2000). The fishery has been observed from January to March off Cape Hatteras, in May and June in the entire mid-Atlantic, and in July through December in the mid-Atlantic Bight and off Nova Scotia. This fishery has been monitored with 3-6% observer coverage, in terms of sets observed, since 1992. The 1993-1997, estimated take was based on a revised analysis of the observed incidental take and self-reported incidental take and effort data, and replace previous estimates for the 1990-1993 and 1994-1995 periods (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999). Further, Yeung (1999b), revised the 1992-1997 fishery mortality estimates in Johnson *et al.* (1999) to include seriously injured animals. The 1998 and 1999 bycatch estimates were from Yeung (1999a) and Yeung *et al.* (2000), respectively. Most of the estimated marine mammal bycatch was from EEZ waters between South Carolina and Cape Cod (Johnson *et al.* 1999). Pilot whales are frequently observed to feed on hooked fish, particularly big-eye tuna (NMFS unpublished data). Between 1992-1999 sixty-two pilot whales (including two identified as a short-finned pilot whales) were released alive, including 32 that were considered seriously injured (of which one was identified as a short-finned pilot whale), and two mortalities were observed. January-March bycatch was concentrated on the continental shelf edge northeast of Cape Hatteras. Bycatch was recorded in this area during April-June, and takes also occurred north of Hydrographer Canyon off the continental shelf in water over 1,000 fathoms during April-June. During the July-September period, takes occurred on the continental shelf edge east of Cape Charles, Virginia, and on Block Canyon slope in over 1,000 fathoms of water. October-December bycatch occurred along the 20 to 50 fathom contour lines between Barnegatt Bay and Cape Hatteras. The estimated fishery-related mortality to pilot whales in the US Atlantic (excluding the Gulf of Mexico) attributable to this fishery was: 127 in 1992 (CV=1.00) and 93 in 1999 (CV=1.00). The estimated serious injuries were 40 (CV=0.71) in 1992, 19 (CV=1.00) in 1993, 232 (CV=0.53) in 1994, 345 (CV= 0.51) in 1995, 0 from 1996 to 1998, and 288 (CV=0.74) in 1999, (includes 37 estimated short-finned pilot whales) in 1995 (CV=1.00); average annual mortality between 1995 and 1999 was 145 pilot whales (0.66) (Table 2). Seriously injured and released alive animals are combined with mortalities in the category 'combined mortality'.

Bluefin Tuna Purse Seine

The tuna purse seine fishery between Cape Hatteras and Cape Cod is directed at small and medium bluefin and skip jack for the canning industry, while north of Cape Cod purse seine vessels are directed at large medium and giant bluefin tuna (NMFS, 1995). The latter fishery is entirely separate from any other Atlantic tuna purse seine fishery. Spotter aircraft are used to locate fish schools. The official start date is August 15, set by regulation. Individual vessel quotas (IVQs) and a limited access system prevent a derby fishery situation. Catch rates are high

with this gear and consequently, the season usually only lasts a few weeks for large mediums and giants. The 1996 regulations allocated 250 MT (5 IVQs) with a minimum of 90% giants and 10% large mediums. Limited observer data are available for the bluefin tuna purse seine fishery. Out of 45 total trips made in 1996, 43 trips (95.6%) were observed. Forty-four sets were made on the 43 observed trips and all sets were observed. A total of 136 days were covered. Two interactions with pilot whales were observed in 1996. In one interaction, the net was actually pursed around one pilot whale, the rings were released and the animal escaped alive, condition unknown. This set occurred east of the Great South Channel and just north of the Cultivator Shoals region on Georges Bank. In a second interaction, five pilot whales were encircled in a set. The net was opened prior to pursuing to let the whales swim free, apparently uninjured. This set occurred on the Cultivator Shoals region on Georges Bank. Since 1996, this fishery ~~was~~ has not been observed. ~~in 1997 and 1998~~

North Atlantic Bottom Trawl

Vessels in the North Atlantic bottom trawl fishery, a Category III fishery under the MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. An average of 970 (CV= 0.04) vessels (full and part time) participated annually in the fishery during 1989-1993. The fishery is active in New England in all seasons. One mortality was documented in 1990, and one animal was released alive and uninjured in 1993. The estimated fishery-related mortality to pilot whales in the USA Atlantic attributable to this fishery was: 0 in 1994-1998, and 228 in 1999. The average annual mortality between ~~1994 and 1998~~ 1995-1999 was 46 pilot whales (CV = 1.03) (Table 2). However, these estimates should be viewed with caution due to the extremely low (<1%) observer coverage.

Squid, Mackerel, Butterfish Trawl

The mid-Atlantic mackerel and squid trawl fisheries were combined into the Atlantic mid-water trawl fishery in the revised proposed list of fisheries in 1995. The fishery occurs along the USA mid-Atlantic continental shelf region between New Brunswick, Canada, and Cape Hatteras year around. The mackerel trawl fishery was classified as a Category II fishery since 1990 and the squid fishery was originally classified as a Category II fishery in 1990, but was reclassified as a Category III fishery in 1992. The combined fishery was reclassified as a Category II fishery in 1995. In 1996, mackerel, squid, and butterfish trawl fisheries were combined into the Atlantic squid, mackerel, butterfish trawl fishery, and maintained a Category II classification. Three fishery-related mortality of pilot whales were reported in self-reported fisheries information from the mackerel trawl fishery between 1990-1992. One mortality was observed in the years 1996, and 1998 and, 1999. The 1996 and 1998 bycatch both occurred in the *Illex* squid fishery, and the 1999 in the *Loligo* fishery. The estimated fishery-related mortality to pilot whales in the USA Atlantic attributable to this fishery was: 45 in 1996 (CV = 1.27), 0 in 1997, and 85 in 1998 (CV = 0.65), and 49 in 1999 (CV = 0.97); average annual mortality between 1996 and ~~1998~~ 1999 was 43 pilot whales (CV=0.64) (Table 2). However, these estimates should be viewed with caution due to the extremely low (<1%) observer coverage.

Mid-Atlantic Coastal Gillnet

Observer coverage of the USA Atlantic coastal gillnet fishery was initiated by the NEFSC Sea Sampling program in July, 1993; and from July to December 1993, 20 trips were observed. During 1994 and 1995 221 and 382 trips were observed, respectively. This fishery, which extends from North Carolina to New York, is actually a combination of small vessel fisheries that target a variety of fish species, some of which operate right off the beach. The number of vessels in this fishery is unknown, because records which are held by both state and federal agencies have not been centralized and standardized. Observer coverage, expressed as percent of tons of fish landed, was 5% 4%, 3%, and 5% for 1995, 1996, 1997, and 1998 (Table 2).

No pilot whales were taken in observed trips during 1993-1997. One pilot whale was observed taken in 1998, and 0 in 1999 (Table 2). Observed effort was concentrated off NJ and scattered between DE and NC from 1 to 50 miles off the beach. All bycatches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 7 in 1998 (1.1). Average annual estimated fishery-related mortality attributable to this fishery during 1995-~~1998~~ 1999 was 2 pilot whale (CV=~~1.1~~ 1.1)

CANADA

An unknown number of pilot whales have also been taken in Newfoundland and Labrador, and Bay of Fundy, groundfish gillnets, Atlantic Canada and Greenland salmon gillnets, and Atlantic Canada cod traps (Read

1994). The Atlantic Canadian and Greenland salmon gillnet fishery is seasonal, with the peak from June to September, depending on location. In southern and eastern Newfoundland, and Labrador during 1989, 2,196 nets 91 m long were used. There are no effort data available for the Greenland fishery; however, the fishery was terminated in 1993 under an agreement between Canada and North Atlantic Salmon Fund (Read 1994).

There were 3,121 cod traps operating in Newfoundland and Labrador during 1979, and about 7,500 in 1980 (Read 1994). This fishery was closed at the end of 1993 due to collapse of Canadian groundfish resources.

Between January 1993 and December 1994, 36 Spanish deep-water trawlers, covering 74 fishing trips, were observed in NAFO Fishing Area 3 (off the Grand Bank) (Lens 1997). A total of 47 incidental catches were recorded, which included one long-finned pilot whale. The incidental mortality rate for pilot whales was 0.007/set.

In Canada, the fisheries observer program places observers on all foreign fishing vessels, on between 25-40% of large Canadian vessels (greater than 100 ft), and on approximately 5% of small vessels (Hooker *et al.* 1997). Fishery observer effort off the coast of Nova Scotia during 1991-1996 varied on a seasonal and annual basis, reflecting changes in fishing effort (see Figure 3, Hooker *et al.* 1997). During the 1991-96 period, long-finned pilot whales were bycaught (number of animals in parentheses) in bottom trawl (65); midwater trawl (6); and longline (1) gear. Recorded bycatches by year were: 16 in 1991, 21 in 1992, 13 in 1994, 9 in 1995, and 6 in 1996. Pilot whale bycatches occurred in all months except January-March and September (Hooker *et al.* 1997).

Table 2. Summary of the incidental mortality of pilot whales (*Globicephala sp.*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the observed mortalities and serious injuries recorded by on-board observers, the estimated annual mortality and serious injury, the combined annual estimates of mortality and serious injury (Estimated Combined Mortality), the estimated CV of the combined estimates (Estimated CVs) and the mean of the combined estimates (CV in parentheses).

Fishery	Years	Vessels	Data Type ¹	Observer Coverage ²	Observed Serious Injury	Observed Mortality	Estimated Serious Injury	Estimated Mortality	Estimated Combined Mortality	Estimated CVs	Mean Annual Mortality
Atlantic ⁵ squid, mackerel, butterfish trawl	96-99	NA	Obs. Data Weighouts	.007, .008, .003, .004	0, 0, 0, 0	6, 0, 1, 1		45, 0, 85, 49		1.27, 0, .65, .97	45 (.52)
N. Atl. ^{3,5} Bottom Trawl	95-99	NA	Obs. Data Weighouts	.011 ⁴ , .002, .002, .001, .003	0, 0, 0, 0, 0	0, 0, 0, 0, 1		0, 0, 0, 0, 228		, 0, 0, 0, 0, 1.03	46 (1.03)
Pelagic ⁶ Longline	95-99	277, 253, 245, 205, 193 ⁷	Obs. Data Logbook	.04, .03, .03, .03, .04	13, 0, 0, 0, 4	0, 0, 0, 0, 1	345, 0, 0, 0, 288	0, 0, 0, 0, 93	345, 0, 0, 0, 381	0.51, 0, 0, 0, 0.79	145 (0.66)
Mid- Atlantic Coastal Gillnet	95-99	NA	Obs. Data Weighouts	.05, .04, .03, .05, .02	0, 0, 0, 0, 0	0, 0, 0, 1, 0		0, 0, 0, 7, 0		0, 0, 0, 1.1, 0	1 (1.1)
Nova Scotia trawl fisheries	95-96	NA	Obs. Data	NA, NA	0, 0, 0, 0	9, 6		9, 6		NA, NA	8 (NA)
TOTAL											245 (0.44)

¹ Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook data were used to measure total effort for the longline fishery. These data are collected at the Southeast Fisheries Science Center (SEFSC).

² Observer coverage of the mid-Atlantic coastal gillnet fishery is measured in tons of fish landed. Observer coverage for the longline fishery are in terms of sets. The trawl fisheries are measured in trips.

³ 1995 estimate not available for the squid, mackerel and butterfish subfisheries.

⁴ Observer coverage for the Atlantic bottom trawl fishery in 1995 is based on only January to May data.

⁵ In 1997 and 1998 the observed pilot whales were taken from the *Illex* squid otter trawl subfishery. The 1999 observed pilot whales were taken from the *Loligo* squid and N. Atlantic otter trawl subfisheries.

⁶ 1995-1999 Mortality estimates were taken from Table 9a in Yeung et al. (NMFS Miami Laboratory PRD 99/00-13), and exclude the Gulf of Mexico.

⁷ Number of vessels in the fishery are based on vessels reporting effort to the pelagic longline logbook.

Other Mortality

Pilot whales have a propensity to mass strand throughout their range, but the role of human activity in these events is unknown. Between two and 120 pilot whales have stranded annually either individually or in groups in NMFS Northeast Region (Anon. 1993b) since 1980. From 1992-1998, 71 long-finned pilot whale stranded between South Carolina and Maine, including 22 animals that mass stranded in 1992 along the Massachusetts coast (NMFS unpublished data).

In eastern Canada, ~~six dead~~ **37 strandings of long-finned pilot whales (173 individuals)** were reported on Sable Island, Nova Scotia from ~~1990-1996~~ **1970-1998** (Lucas and Hooker 1997; **Lucas and Hooker 2000**). **This included 130 animals that mass stranded in December 1976, and two smaller groups (<10 each) in autumn 1979 and summer 1992.** Fourteen strandings **were also recorded** along Nova Scotia from 1991-1996 (Hooker *et al.* 1997; ~~Lucas and Hooker 1997~~).

A potential human-caused source of mortality is from polychlorinated biphenyls (PCBs) and **chlorinated pesticides** (DDT, **DDE, dieldrin, etc.**) moderate levels of which have been found in pilot whale blubber (Taruski 1975; Muir *et al.* 1988; **Weisbrod *et al.* 2000**). **Weisbrod *et al.* (2000), reported that bioaccumulation levels were more similar in whales from the same standing group than animals of the same sex or age. Also, high levels of toxic metals (mercury, lead, cadmium) and selenium were measured in pilot whales harvested in the Faroe Island drive fishery (Nielsen *et al.* 2000). The population effect of the observed levels of such contaminants is unknown.**

STATUS OF STOCK

The status of long-finned pilot whales relative to OSP in USA Atlantic EEZ is unknown, but stock abundance may have been affected by reduction in foreign fishing, curtailment of the Newfoundland drive fishery for pilot whales in 1971, and increased abundance of herring, mackerel, and squid stocks. There are insufficient data to determine the population trends for this species. The species is not listed under the Endangered Species Act. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because the ~~1994-1998~~ **1995-1999** estimated average annual fishery-related mortality, excluding Nova Scotia bycatches to pilot whales, *Globicephala* sp., exceeds PBR.

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WHITE-SIDED DOLPHIN (*Lagenorhynchus acutus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

White-sided dolphins are found in temperate and sub-polar waters of the North Atlantic, primarily on continental shelf waters to the 100 m depth contour. The species inhabits waters from central west Greenland to North Carolina (about 35°N) and perhaps as far east as 43° W (Evans 1987). Distribution of sightings, strandings and incidental takes suggests the possible existence of three stocks units: a Gulf of Maine, Gulf of St. Lawrence, and a Labrador Sea stock (Palka *et al.* 1997). ~~No A genetic study is currently being~~ have been conducted to test this proposed population structure; ~~although some samples are available to initiate such a study.~~ Evidence for a separation between the well documented unit in the southern Gulf of Maine and a Gulf of St. Lawrence population comes from a hiatus of summer sightings along the Atlantic side of Nova Scotia. This has been reported in Gaskin (1992), is evident in Smithsonian stranding records, and was seen during an abundance surveys conducted in summers 1995 and 1999 that covered waters from Virginia to the entrance of the Gulf of St. Lawrence. White-sided dolphins were seen frequently in eastern Gulf of Maine waters and in waters at the mouth of the Gulf of St. Lawrence, but only a few sightings were recorded in the waters between these two regions.

The Gulf of Maine stock of white-sided dolphins are most common in continental shelf waters from Hudson Canyon (approximately 39°N) north through Georges Bank, and in the Gulf of Maine to the lower Bay of Fundy. Sightings data indicate seasonal shifts in distribution (Northridge *et al.* 1997). During January to April, low numbers of white-sided dolphins are found from Georges Bank to Jeffreys Ledge (off New Hampshire), and even lower numbers are south of Georges Bank, as documented by a few strandings collected on beaches of Virginia and North Carolina. From June through September, large numbers of white-sided dolphins are found from Georges Bank to lower Bay of Fundy. From October to December, white-sided dolphins occur at intermediate densities from southern Georges Bank to southern Gulf of Maine (Payne and Heinemann 1990). Sightings south of Georges Bank, in particular, around Hudson Canyon have been seen at all times of the year but at low densities. The Virginia and North Carolina observations appear to represent the southern extent of the species range.

Prior to the 1970's, white-sided dolphins in USA waters were found primarily offshore on the continental slope, while white-beaked dolphins (*L. albirostris*) were found on the continental shelf. During the 1970's, there was an apparent switch in habitat use between these two species. This shift may of been a result of the increase in sand lance in the continental shelf waters (Katona *et al.* 1993; Kenney *et al.* 1996).

POPULATION SIZE

The total number of white-sided dolphins along the eastern USA and Canadian Atlantic coast is unknown, although ~~five~~four estimates from select regions are available: i) from spring, summer and autumn 1978-82, ii) July-September 1991-92, iii) June-July 1993, ~~and~~ iv) July-September 1995, and v) July-August 1999 (Table 1; Figure 1).

An abundance of 28,600 white-sided dolphins (CV=0.21) was estimated from an aerial survey

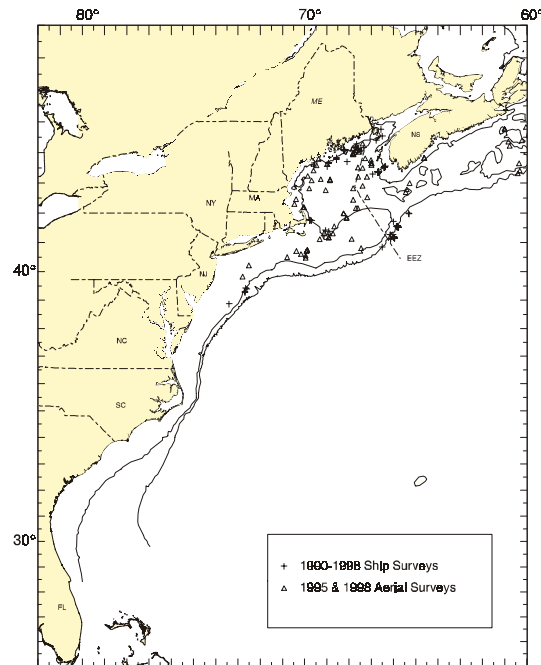


Figure 1. Distribution of white-sided dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and 1,000 m.

program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982).

An abundance of 20,400 (CV=0.63) white-sided dolphins was estimated from two shipboard line transect surveys conducted during July to September 1991 and 1992 in the northern Gulf of Maine-lower Bay of Fundy region (Table 1; Palka *et al.* 1997). This population size is a weighted-average of the 1991 and 1992 estimates, where each annual estimate was weighted by the inverse of its variance.

An abundance of 729 (CV=0.47) white-sided dolphins was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993).

An abundance of 27,200 (CV=0.43) white-sided dolphins was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; Palka *et al.* in review). Total track line length was 32,600 km. The ships covered waters between the 50 and 1000 fathom contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom contour line. Data collection and analysis methods used were described in Palka (1996).

An abundance of 51,640 (CV=0.38) white-sided dolphins was estimated from a 28 July to 31 August 1999 line-transect sighting survey conducted from a ship and an airplane covering waters from Georges Bank to the mouth of the Gulf of St. Lawrence (Table 1; Figure 1 (to be done still); D. Palka, pers. comm.). Total track line length was 8,212 km. Similar to that used in the above 1995 Virginia to Gulf of St. Lawrence survey, shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$ (Palka 2000). This abundance estimate is larger than the 1995 estimate because only during the 1999 survey were track lines surveyed and white-sided dolphins detected in the upper Bay of Fundy and on the northern edge of Georges Bank.

Kingsley and Reeves (1998) estimated there were 11,740 (CV=0.47) white-sided dolphins in the Gulf of St. Lawrence during 1995 and 560 (CV=0.89) white-sided dolphins in the northern Gulf of St. Lawrence during 1996. It is assumed these estimates apply to the Gulf of St. Lawrence stock. During the 1995 survey, 8,427 km of track lines were flown in an area of 221,949 km² during August and September. During the 1996 survey, 3,993 km of track lines were flown in an area of 94,665 km² during July and August. Data were analyzed using Quenouille's jackknife bias reduction procedure on line transect methods that model the left truncated sighting curve. These estimates were uncorrected for visibility biases, such as $g(0)$.

The best available current abundance estimate for white-sided dolphins in the Gulf of Maine stock is 51,640 (CV=0.38) 27,200 (CV=0.43) as estimated from the July to August 1999 September 1995 line transect survey because this survey is recent and provided the most complete coverage of the known habitat.

Table 1. Summary of abundance estimates for western North Atlantic white-sided dolphins. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Gulf of Maine stock			
Jul-Sep 1991-92	N. Gulf of Maine and lower Bay of Fundy	20,400	0.63
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	729	0.47
Jul-Sep 1995	Virginia to mouth of Gulf of St. Lawrence	27,200	0.43
Jul-Aug 1999	Georges Bank to mouth of Gulf of St. Lawrence	51,640	0.38
Gulf of St. Lawrence stock			

Month/Year	Area	N _{best}	CV
Aug-Sep 1995	entire Gulf of St. Lawrence	11,740	0.47
July-Aug 1996	northern Gulf of St. Lawrence	560	0.89

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for the Gulf of Maine stock of white-sided dolphins is ~~51,640 (CV=0.38)~~ ~~27,200 (CV=0.43)~~ ~~19,196 (CV=0.43)~~. The minimum population estimate for these white-sided dolphins is ~~37,904 (CV=0.38)~~ ~~19,196 (CV=0.43)~~.

Current Population Trend

There are insufficient data to determine population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include: calving interval is 2-3 years; lactation period is 18 months; gestation period is 10-12 months and births occur from May to early August, mainly in June and July; length at birth is 110 cm; length at sexual maturity is 230-240 cm for males, and 201-222 cm for females; age at sexual maturity is 8-9 years for males and 6-8 years for females; mean adult length is 250 cm for males and 224 cm for females (Evans 1987); and maximum reported age for males is 22 years and for females, 27 years (Sergeant *et al.* 1980).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is ~~37,904 (CV=0.38)~~ ~~19,196 (CV=0.43)~~. The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.48 because this stock is of unknown status and the CV of the mortality estimate is between 0.3 and 0.6. PBR for the Gulf of Maine stock of the western North Atlantic white-sided dolphin is ~~364~~ ~~184~~.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Recently, within USA waters, white-sided dolphins have been caught in the Northeast ~~multispecies~~ sink gillnet, mid-Atlantic coastal gillnet, pelagic drift gillnet, North Atlantic bottom trawl, and Atlantic squid, mackerel, butterflyfish trawl fisheries (Table 2). Estimated average annual fishery-related mortality and serious injury to the Gulf of Maine stock of the western North Atlantic white-sided dolphin from these USA fisheries during 1995-1999 was ~~136 (CV=0.52)~~ ~~223~~ dolphins per year ~~(CV=0.44)~~.

EARLIER INTERACTIONS

In the past, incidental takes of white-sided dolphins have been recorded in the Northeast and Bay of Fundy ~~multispecies~~ gillnet fisheries and the Atlantic foreign mackerel fishery. In the mid 1980's, during a University of Maine study, gillnet fishermen reported six takes of white-sided dolphins of which two carcasses were necropsied for biological studies (Gilbert and Wynne 1987; Gaskin 1992). NMFS foreign fishery observers have reported 44 takes of Atlantic white-sided dolphins incidental to fishing activities in the continental shelf and continental slope waters between March 1977 and December 1991 (Waring *et al.* 1990; NMFS unpublished data). Of these animals, 96% were taken in the Atlantic mackerel fishery. This total includes nine documented takes by USA vessels involved in joint-venture fishing operations in which USA captains transfer their catches to foreign processing vessels. Prior to 1977, there was no

documentation of marine mammal bycatch in distant-water fleet (DWF) activities off the northeast coast of the USA. With implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA) in that year, an observer program was established which recorded fishery data and information of incidental bycatch of marine mammals. DWF effort in the USA Atlantic Exclusive Economic Zone (EEZ) under MFCMA had been directed primarily towards Atlantic mackerel and squid. From 1977 through 1982, an average of 120 different foreign vessels per year (range 102-161) operated within the Atlantic coast EEZ. In 1982, there were 112 different foreign vessels; 16%, or 18, were Japanese tuna longline vessels operating along the USA east coast. This was the first year that the Northeast Regional Observer Program assumed responsibility for observer coverage of the longline vessels. Between 1983 and 1991, the numbers of foreign vessels operating within the Atlantic coast EEZ each year were 67, 52, 62, 33, 27, 26, 14, 13, and 9, respectively. Between 1983 and 1988, the numbers of DWF vessels included 3, 5, 7, 6, 8, and 8, respectively, Japanese longline vessels. Observer coverage on DWF vessels was 25-35% during 1977-82, and increased to 58%, 86%, 95%, and 98%, respectively, in 1983-86; 100% observer coverage was maintained during 1987-91. Foreign fishing operations for squid ceased at the end of the 1986 fishing season and for mackerel at the end of the 1991 season.

Pelagic Drift Gillnet

In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. The fishery operated during 1998. Then, in January 1999 NMFS issued a Final Rule to prohibit the use of drift net gear in the North Atlantic swordfish fishery (50 CFR Part 630). During 1991 to 1998, two white-sided dolphins were observed taken in the Atlantic pelagic drift gillnet fishery, both in 1993. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The estimated total number of hauls in the Atlantic pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991 to 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. In 1994 to 1998, there were 11, 12, 10, 0, and 11 vessels, respectively, in the fishery (Table 2). Observer coverage, expressed as percent of sets observed was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, 64% in 1996, no fishery in 1997, and 99% coverage during 1998. Observer coverage dropped during 1996 because some vessels were deemed too small or unsafe by the contractor that provided observer coverage to NMFS. Fishing effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the drift gillnet fishery is stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Total annual bycatch after 1993 were estimated for each year separately by summing the observed caught with the product of the average bycatch per haul and the number of unobserved hauls as recorded in logbooks. Variances were estimated using bootstrap re-sampling techniques (Bisack 1997b). Estimated annual fishery-related mortality and serious injury (CV in parentheses) was 4.4 (.71) in 1989, 6.8 (.71) in 1990, 0.9 (.71) in 1991, 0.8 (.71) in 1992, 2.7 (0.17) in 1993, and 0 in 1994 to 1998. There was no fishery during 1997. Estimated average annual mortality and serious injury related to this fishery during 1994-1996, and 1998 was 0.0 white-sided dolphins. Since this fishery no longer exists, it was removed from Table 2.

USA

Northeast ~~Multispecies-Sink~~ Gillnet

Between 1990 and 1998 there were 440 mortalities observed in the Northeast ~~multispecies-sink~~ gillnet fishery (Table 2). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year this fishery has been covered by the program. In 1993 there were approximately 349 vessels (full and part time) in the Northeast ~~multispecies-sink~~ gillnet fishery (Walden 1996). During 1998 it was estimated there were 301 full and part-time vessels participating in this fishery. This is the number of unique vessels in the commercial landings database (Weighout) that reported catch from this fishery during 1998 from the states of Rhode Island and north. This does not include a small percentage of records where the vessel number was missing. Observer coverage, expressed as a percentage of the number of trips, has been 1%, 6%, 7%, 5%, 7%, 5%, 4%, 6%, ~~and 5%~~, and 6% for years 1990 to 1998, respectively. Most white-sided dolphins have been taken in waters south of Cape Ann during April to December. In recent years, the majority of the takes have been east and south of Cape Cod. Estimated annual fishery-related mortalities (CV in parentheses) were 49 (0.46) in 1991, 154 (0.35) in 1992, 205 (0.31) in 1993, 240 (0.51) in 1994, 80

(1.16) in 1995, 114 (0.61) in 1996 (Bisack 1997a), 140 (0.61) in 1997, and 34 (0.92) in 1998, and 69 (0.70) in 1999. Average annual estimated fishery-related mortality during 1995-1998 was 87±22 white-sided dolphins per year (0.70±) (Table 2).

Mid-Atlantic Coastal Gillnet

One white-sided dolphin was observed taken in this fishery during 1997 (Table 2). None were taken in observed trips during 1993 to 1996, and none in 1998 and 1999. In July 1993, an observer program was initiated in the USA mid-Atlantic coastal gillnet fishery by the NEFSC Sea Sampling program. Twenty trips were observed during 1993. During 1994 and 1995 221 and 382 trips were observed, respectively. This fishery, which extends from North Carolina to New York, is actually a combination of small vessel fisheries that target a variety of fish species, some of the vessels operate right off the beach, some using drift nets, and others using sink nets attached to the bottom. During 1998, it was estimated there were 302 full and part-time sink gillnet vessels and an undetermined number of drift gillnet vessels participating in this fishery. This is the number of unique vessels in the commercial landings database (Weighout) that reported catch from this fishery during 1998 from the states of Connecticut to North Carolina. This does not include a small percentage of records where the vessel number was missing. Observer coverage, expressed as percent of tons of fish landed, was 5%, 4%, 3%, and 5%, and 2% for 1995 to 1998, respectively (Table 2). Observed fishing effort was concentrated off New Jersey and scattered between Delaware and North Carolina from the beach to 50 miles off the beach. Bycatch estimates were determined using methods similar to that used for bycatch estimates in the Northeast multispecies gillnet fishery (Bravington and Bisack 1996; Bisack 1997a). Using the observed takes of white-sided dolphins, the estimated annual mortality (CV in parentheses) attributed to this fishery was 0 for 1993 to 1996, and 1998, and 1999, and 45 (0.82) for 1997. However, because the spatial-temporal distribution of observer coverage did not cover all types of gillnet fisheries in the mid-Atlantic region during all times of the year, it is likely that these figures are underestimates. Average estimated white-sided dolphin mortality and serious injury from the mid-Atlantic coastal gillnet fishery during 1995 to 1998 was 9± (CV=0.82) (Table 2).

Pelagic Drift Gillnet

Because there have been no observed takes of white-sided dolphins in this fishery recently, 1994 to 1998, next time this section will be moved to the "Earlier Interactions" section above. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. The fishery operated during 1998. Then, in January 1999 NMFS issued a Final Rule to prohibit the use of drift net gear in the North Atlantic swordfish fishery (50 CFR Part 630). During 1991 to 1998, two white-sided dolphins were observed taken in the Atlantic pelagic drift gillnet fishery, both in 1993. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The estimated total number of hauls in the Atlantic pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991 to 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. In 1994 to 1998, there were 11, 12, 10, 0, and 11 vessels, respectively, in the fishery (Table 2). Observer coverage, expressed as percent of sets observed was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, 64% in 1996, no fishery in 1997, and 99% coverage during 1998. Observer coverage dropped during 1996 because some vessels were deemed too small or unsafe by the contractor that provided observer coverage to NMFS. Fishing effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the drift gillnet fishery is stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Total annual bycatch after 1993 were estimated for each year separately by summing the observed caught with the product of the average bycatch per haul and the number of unobserved hauls as recorded in logbooks. Variances were estimated using bootstrap re-sampling techniques (Bisack 1997b). Estimated annual fishery-related mortality and serious injury (CV in parentheses) was 4.4 (.71) in 1989, 6.8 (.71) in 1990, 0.9 (.71) in 1991, 0.8 (.71) in 1992, 2.7 (0.17) in 1993, and 0 in 1994 to 1998. There was no fishery during 1997. Estimated average annual mortality and serious injury related to this fishery during 1994-1996, and 1998 was 0.0 white-sided dolphins (Table 2).

North Atlantic Bottom Trawl

Because there have been no observed takes of white-sided dolphins in this fishery recently, 1995 to 1999, next time this section will be moved to the "Earlier Interactions" section above. Three mortalities were documented between

1991 and 1999~~8~~ in the North Atlantic bottom trawl fishery (Table 2). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year this fishery has been covered by the program, though at a low level. The observer coverage was 0.4% in 1994, 1.1% in 1995, 0.2% in 1996, 0.2% in 1997, ~~and 0.1%~~ in 1998, ~~and 0.3% in 1999~~. Vessels in the North Atlantic bottom trawl fishery, a Category III fishery under the MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. An average of 970 (CV= 0.04) vessels (full and part time) participated annually in the fishery during 1989-1993. The fishery is active in New England waters in all seasons. The one white-sided dolphin taken in 1992 was taken in a haul that was composed of 43% cod, 20% silver hake, and 17% pollock. One of the 1994 takes was in a haul that was composed of 42% white hake, 19% pollock, and 16% monkfish. The other 1994 take was in a haul that kept seven species of which none were dominant. The estimated fishery-related mortality in 1992 was 110 (CV=0.97), in 1994 it was 182 (CV=0.71), and it was 0 in other years (Bisack 1997b). The average annual estimate fishery-related mortality during 1995~~4~~-1999~~8~~ was ~~0-36.4~~ white-sided dolphins (~~CV=0.71~~) (Table 2).

Squid, Mackerel, Butterfish Trawl

One white-sided dolphin was observed taken in the mackerel sub-fishery during 1997 (Table 2). The squid, mackerel, butterfish trawl fishery, though managed under one fishery management plan by the mid-Atlantic Fisheries Management Council, is actually three independent fisheries operating in different areas during different times of the year (NMFS 1998). The *Loligo* squid sub-fishery is mostly in southern New England, New York and mid-Atlantic waters, where fishing patterns reflect the seasonal migration of the *Loligo* (offshore during October to March and inshore during April to September). The *Illex* squid sub-fishery is primarily on the continental slope during June to September. The mackerel sub-fishery during January to May is primarily in the southern New England and mid-Atlantic waters, while during May to December, it is primarily in the Gulf of Maine. Butterfish is primarily a bycatch of the squid and mackerel sub-fisheries. Butterfish migrate north and inshore during the summer, and south and offshore during the winter. In 1995, the squid, mackerel, butterfish trawl fishery was classified as a Category II fishery. Observer coverage was very low; as expressed as percentage of trips observed, it was 0.7% in 1996, 0.8% in 1997, ~~and 0.3% in 1998~~, ~~and 0.4% in 1999~~. The bycatch, stratified by sub-fishery, season and geographical area, was estimated using the ratio estimator method, as was documented in Bisack (1997b). The estimated fishery-related mortality was 0 in 1996, 161 (CV=1.58) in 1997, and 0 in 1998 ~~and 1999~~. The average annual estimated fishery-related mortality during 1996 to 1999~~8~~ was ~~4054~~ (CV=1.58) (Table 2).

Table 2. Summary of the incidental mortality of white-sided dolphins (*Lagenorhynchus acutus*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type ¹	Observer Coverage ²	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Northeast Multispecies Sink Gillnet	94-98 95-99	1993=349 1998=301	Obs. Data Weighout Trip Logbook	.07, .05, .04, .06,.05, .06	10³, 2 ³ , 2 ³ , 4 ³ , 1 ³ , 4 ³	240³, 80 ³ ,114 ³ , 140 ³ ,34 ³ , 69 ³	.51, 1.16,.61, .61,.92,.70	122 (0.31) 87 (0.35)
Mid-Atlantic Coastal Gillnet	95-98 99	1998=302 ⁸	Obs. Data Weighout	.05, .04, .03, .05, .02	0, 0, 1, 0, 0	0, 0, 45, 0, 0	0, 0, , .82, 0, 0	11 (0.82) 9 (0.82)
Pelagic Drift Gillnet	94-98⁵	1994=11 1995=12 1996=10 1997=NA⁵ 1998=13	Obs. Data Logbook	.87, .99,.64, NA⁵, .99	0, 0, 0, NA⁵, 0	0, 0, 0, NA⁵, 0	0, 0, 0, NA⁵, 0	0.0⁵ (0.0)

Fishery	Years	Vessels	Data Type ¹	Observer Coverage ²	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
North Atlantic Bottom Trawl	94-98 95-99	1993=970	Obs. Data Weighout	.004, .011 ⁴ , .002, .002, .001, .003	2, 0, 0, 0, 0, 0	182, 0, 0, 0, 0, 0	.71, 0, 0, 0, 0, 0	36.4 (0.71) 0 (0.0)
Squid, Mackerel, Butterfish Trawl	96-98 99	Unk ⁷	Obs. Data Weighout	.007, .008, .003, .004	0, 1 ⁶ , 0, 0	0, 161 ⁶ , 0, 0	0, 1.58 ⁶ , 0, 0	54 (1.58) 40 (1.58)
Total								223 (0.44) 136 .52

¹ Observer data (Obs. Data), used to measure bycatch rates, are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects ~~Weighout~~ landings data (Weighout) which is used as a measure of total effort. Mandatory trip logbook (Trip Logbook) data are used to determine the spatial distribution of ~~some~~ fishing effort in the sink gillnet fishery. ~~Mandatory logbook (Logbook) data, used to measure total effort for the pelagic drift gillnet fishery, are collected at the Southeast Fisheries Science Center (SEFSC).~~

² Observer coverage for the Northeast sink gillnet and both trawl fisheries are measured in trips; ~~the pelagic drift gillnet fishery is measured in sets~~, and the mid-Atlantic coastal gillnet fishery is measured in tons of fish landed.

³ White-sided dolphins taken before 1997 in observed pinger trips were added directly to the estimated total bycatch for that year. **During 1998 and 1999, a weighted bycatch rate was applied to effort from both pingered and non-pingered hauls within the stratum where white-sided dolphins were observed taken.** ~~White-sided dolphins taken on observed pinger trips were added directly to the estimated total bycatch for that year when there was no closure in effect. During the years 1994, 1997 and 1999 respectively, there were 1, 2 and 1 one observed white-sided dolphins taken on a pingered trips. in 1994, and two takes on pinger trips during 1997; these three takes were not included in the observed mortality count. No takes were observed on pinger trips during 1995, 1996, and 1998.~~

⁴ Observer coverage for the Atlantic bottom trawl fishery in 1995 is based on only January to May data (the only time takes were observed).

⁵ ~~Fishery closed during 1997. So average bycatch is from 1994, 1995, 1996, and 1998.~~

⁶ The observed take was in the mackerel sub-fishery.

⁷ Number of vessels is unknown.

⁸ **Number of sink gillnet vessels, undetermined number of drift gillnet vessels.**

CANADA

There is little information available which quantifies fishery interactions involving white-sided dolphins in Canadian waters. Two white-sided dolphins were reported caught in groundfish gillnet sets in the Bay of Fundy during 1985 to 1989, and nine were reported taken in West Greenland between 1964 and 1966 in the now non-operational salmon drift nets (Gaskin 1992). Several (number not specified) were also taken during the 1960's in the now non-operational Newfoundland and Labrador groundfish gillnets. A few were taken in an experimental drift gillnet fishery for salmon off West Greenland which took place from 1965 to 1982 (Read 1994). Hooker *et al.* (1997) summarized bycatch data from a Canadian fisheries observer program that placed observers on all foreign fishing vessels operating in Canadian waters, on between 25-40% of large Canadian fishing vessels (greater than 100 feet long), and on approximately 5% of smaller Canadian fishing vessels. By-caught marine mammals were noted as weight in kilos rather than by the numbers of animals caught. Thus the number of individuals was estimated by dividing the total weight per

species per trip by the maximum recorded weight of each species. During 1991 through 1996, it was estimated six white-sided dolphins were observed taken. One from a long line trip south of the Grand Banks (43° 10'N 53° 08'W) in November 1996. The other five were taken in the bottom trawl fishery off Nova Scotia in the Atlantic Ocean: 1 in July 1991, 1 in April 1992, 1 in May 1992, 1 in April 1993, 1 in June 1993 and 0 in 1994 to 1996.

Other Mortality

USA

Mass strandings involving up to a hundred or more animals at one time are common for this species. From 1968 to 1995, 349 Atlantic white-sided dolphins were known to have stranded on the New England coast (Hain and Waring 1994; Smithsonian stranding records 1996). The causes of these strandings are not known. Because such strandings have been known since antiquity, it could be presumed that recent strandings are a normal condition (Gaskin 1992). It is unknown whether human causes, such as fishery interactions and pollution, have increased the number of strandings. Stranding data probably underestimate the extent of fishery-related mortality and serious injury because not all of the marine mammals which die or are seriously injured may wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery-interaction. Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of fishery interaction.

During 1997, there were 17 recorded stranded white-sided dolphins, of which 16 died and one was released alive (from Rhode Island during February), according to the NE Regional Office/NMFS strandings and entanglement database. One stranding was in Virginia during March, the rest were from Maryland to Maine during January to August, where 10 were from Massachusetts. The cause of death of these strandings were not determined.

During 1998, there were 88 stranded white-sided dolphins documented in the NE Regional Office/NMFS strandings and entanglement database. One stranding, from Delaware during May, was probably a fishery interaction. The rest of the recorded strandings were from Massachusetts, where 65, 16, 2 and 4 were recorded during January, February, April, May, and November, respectively. There were 70 animals found in a mass stranding, near Wellfleet, Massachusetts, during the week of January 29 to February 3. Of these, two were released alive. Of the four found during the November mass stranding, one was released alive.

The NE Regional Office/NMFS strandings and entanglement records of small cetaceans are currently being audited. When this is complete, updates will be provided.

CANADA

Whales and dolphins stranded during 1991 and 1996 on the coast of Nova Scotia were documented by the Nova Scotia Stranding Network (Hooker *et al.* 1997). Strandings on the beaches of Sable Island during 1970 to 1998 were documented by researchers with Fisheries and Oceans, Canada (Lucas and Hooker 2000+1997). Sable Island is approximately 170 km southeast of mainland Nova Scotia. The white-sided dolphins stranded at nearly all times of the year on the mainland and on Sable Island. On the mainland of Nova Scotia, a total of 34 stranded white-sided dolphins were recorded between 1991 and 1996 (Table 3). During July 1992, 26 white-sided dolphins stranded on the Atlantic side of Cape Breton. Of these 26, 11 were released alive and the rest were found dead. Among the rest of the Nova Scotia strandings, one was found in Minas Basin, two near Yarmouth and the rest near Halifax. On Sable Island, 108 stranded white-sided dolphins were documented between 1991 and 1998, all were males, seven were young males (< 200 cm) (Table 3).

Table 3. Documented number of stranded white-sided dolphins, by month and year, along the coast of Nova Scotia (Hooker *et al.* 1997), and on Sable Island (Lucas and Hooker 2000+1996).

Year	Month	Number of strandings	
		Nova Scotia	Sable Island
1991	Aug	1	0

	Oct	1	0
1992	Jul	26	0
1993	Jan	0	1
	Mar	0	5
	Nov	1	0
1994	Feb	1	0
	Nov	1	0
1995	Apr	1	0
	Aug	1	1
1996	Oct	1	0
	Dec	0	1
1997	April	NA	1
1998	Feb	NA	1
TOTAL		34	108

NA = Not available.

STATUS OF STOCK

The status of white-sided dolphins, relative to OSP, in the USA Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine population trends for this species. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a **non**-strategic stock because estimated average annual fishery-related mortality and serious injury **does not** exceeds PBR.

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BOTTLENOSE DOLPHIN (*Tursiops truncatus*): Western North Atlantic Coastal Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

There are two distinct bottlenose dolphin ecotypes (Duffield *et al.* 1983; Duffield 1986; Mead and Potter 1995; Walker *et al.* 1999); a shallow water ecotype and a deep water ecotype which correspond to nearshore and offshore forms, respectively. Both ecotypes have been shown to inhabit waters in the western North Atlantic Ocean (Hersh and Duffield 1990; Mead and Potter 1995; Hoelzel *et al.* 1998; Walker *et al.* 1999). The inshore and offshore forms, of all age classes, can be positively identified based on differences in morphometrics, parasite loads, and prey (Mead and Potter 1995). Hoelzel *et al.* (1998) found significant differentiation between the nearshore and offshore forms in both nuclear and mtDNA markers, and concluded the two forms were distinct. Curry (1997) concluded that, based on differences in mtDNA haplotypes, the nearshore animals in the northern Gulf of Mexico and the western North Atlantic were significantly different stocks. Bottlenose dolphins which had stranded alive in the western North Atlantic in areas with direct access to deep oceanic waters had hemoglobin profiles matching that of the deep, cold water ecotype (Hersh and Duffield 1990). Hersh and Duffield (1990) also described morphological differences between the deep, cold water ecotype dolphins and dolphins with hematological profiles matching the shallow, warm water ecotype which had stranded in the Indian/Banana River in Florida. Because of their occurrence in shallow, relatively warm waters along the USA Atlantic coast and because their morphological characteristics are similar to the shallow, warm water ecotype described by Hersh and Duffield (1990), the Atlantic coastal bottlenose dolphin stock is believed to consist of this ecotype or nearshore form. Furthermore, Hoelzel *et al.* (1998) genetically identified a sample of animals captured or incidentally caught in nearshore waters as the nearshore form. Currently, data are insufficient to allow separation of locally resident bottlenose dolphins found in bays, sounds and estuaries (such as those from the Indian/Banana River) from the coastal stock in the western North Atlantic; Hoelzel *et al.* (1998) found less variation in nuclear and mtDNA markers among their sample of nearshore animals, which likely included resident and coastal animals, than their sample of offshore animals.

The structure of the coastal bottlenose dolphin stock in the western North Atlantic is uncertain, but what is known about it suggests that the structure is complex. Some portion of the coastal stock migrates north of Cape Hatteras,

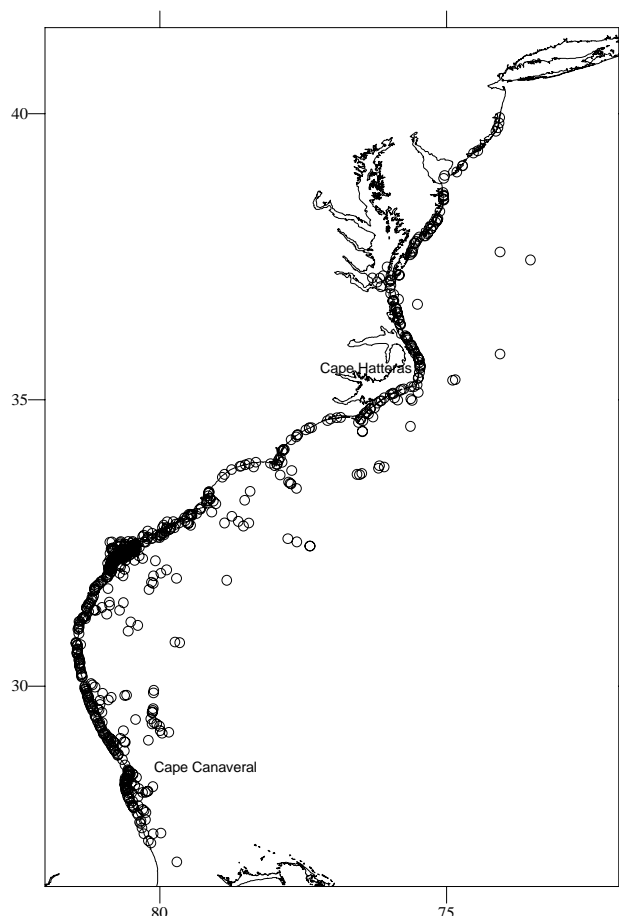


Figure 1. Sightings of bottlenose dolphins during aerial surveys from shore to the 25 m isobath north of Cape Hatteras during summer 1994, shore to 9 km past the western Gulf Stream wall south of Cape Hatteras during winter 1992, three coastal surveys within one km of shore from New Jersey to mid-Florida during the summer in 1994, and during vessel surveys from about the 30 m isobath to the offshore extent of the USA EEZ in 1998.

North Carolina, to New Jersey during the summer (Scott *et al.* 1988). It has been suggested that this stock is restricted to waters < 25 m in depth within the northern portion of its range (Kenney 1990) because there are two concentrations of animals north of Cape Hatteras, one inshore of the 25m isobath and the other offshore of the 25m isobath, which were observed during aerial surveys of the region (CETAP 1982) and vessel surveys (NMFS unpublished data). The lowest density of bottlenose dolphins was observed over the continental shelf, with higher densities along the coast and near the continental shelf edge. The coastal stock is believed to reside south of Cape Hatteras in the late winter (Mead 1975; Kenney 1990); however, the depth distribution of the stock south of Cape Hatteras is uncertain and the coastal and offshore stocks may overlap there. There was no apparent longitudinal discontinuity in bottlenose dolphin herd sightings during aerial surveys south of Cape Hatteras in the winter (Blaylock and Hoggard 1994).

Scott *et al.* (1988) hypothesized a single coastal migratory stock ranging seasonally from as far north as Long Island, NY, to as far south as central

Florida, citing stranding patterns during a high mortality event in 1987-88 and observed density patterns along the USA Atlantic coast. Figure 1 illustrates the distribution of 696 bottlenose dolphin herd sightings during aerial and vessel surveys conducted during 1992-1998. The proportion of the sightings illustrated which might be of bottlenose dolphins from other than the coastal stock is unknown; however, it is reasonable to assume that the coastal surveys within one km of shore minimized inclusion of the offshore stock. Gathering information to distinguish between coastal and offshore ecotypes is currently an active area of research by NMFS Southeast Fisheries Science Center (SEFSC), as is research to determine the relationship between bottlenose dolphin that inhabit bays, sounds and estuaries and those that are believed to comprise the coastal stock (Hohn 1997).

A multi-disciplinary, multi-investigator research program to understand the stock structure of Atlantic coastal bottlenose dolphins was initiated in late 1996. Several different hypotheses about stock structure are being considered (Figure 2). The experimental design for the program is based on: 1) obtaining samples from live captures, photo-identification, projectile biopsy, and incidental take (strandings and observer programs); 2) conducting independent analyses including genetics, isotope ratios, contaminants, movement patterns, morphometrics, telemetry, and life history; and 3) merging of the disassociated results to describe stock structure (Hohn 1997). Based on current information, it is expected that multiple stocks exist and include year-round residents, seasonal residents, and migratory groups. Site-specific, year-round residents have been reported only in the southern

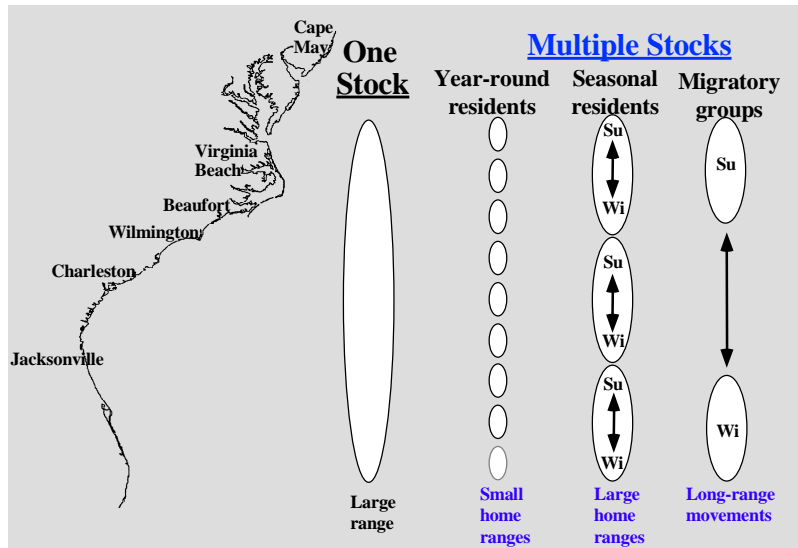


Figure 2. Illustration of stock structure hypotheses of Atlantic coastal bottlenose dolphins: one stock ranging from New Jersey to Florida or multiple stocks which may include: 1) year-round residents with small home ranges; 2) multiple, contiguous, seasonally resident groups with relatively large home ranges; and 3) groups with long-range migratory pattern.

Table 1. Residency and movement patterns of bottlenose dolphins documented from photo-identification (from Hohn 1997).

Location	Year-round Residents	Seasonal Residents	Migratory/ Transient
Virginia Beach, VA	No	Jun-Sept	Jun-Sept
Beaufort, NC, "coastal"	No	Oct-Apr	?
Beaufort, NC, "estuarine"	Possible large home range		
Wilmington, NC			
Charleston, SC	Yes	fall-winter	spring, fall
Bull Creek, SC	Yes	Yes	

part of the range, from Charleston, South Carolina (Zolman 1996) and Georgia (Petricig 1995) to central Florida (Odell and Asper 1990);

seasonal residents and migratory or transient animals also occur in these areas. In the northern part of the range the patterns reported include seasonal residency, year-round residency with large home range, and migratory or transient movements (Barco and Swingle 1996, Sayigh *et al.* 1997). Table I lists the locations and the patterns of residency and movement that have been documented through photo-identification of naturally-marked animals, and of 31 individuals animals that were live-captured and freeze-branded in Beaufort, NC in 1995 (Hansen and Wells 1996). Complex patterns of movement and residency were observed in a sample of 10 of the animals live-captured in Beaufort that were radio-tagged and tracked for up to 31 days: some left the area immediately, some were located up to 120 km distant within a few days of tagging, and others remained in the area (Read *et al.* 1996).

The observed patterns of year-round residency and seasonal residency, and migratory and transient movements likely represent a population that consists of a complex mosaic of biologically-meaningful stocks. The patterns are in some cases essentially identical or very similar to patterns observed in recognized stocks or communities identified in embayments and coastal areas in the northern Gulf of Mexico (e.g. Scott *et al.* 1990; Weller 1998; Wells *et al.* 1996). Sufficient information exists to identify year-round resident communities in several bay and estuarine areas; however, much of the suitable bay and estuarine habitats along the Atlantic coast have not yet been studied sufficiently. Although numerous research efforts are underway, it will require several years of photographic identification, genetic and radio-tracking research to provide sufficient information for interpretation. The entire range(s) and number of migratory and transient stocks are unknown, but much of the current research effort is directed towards determining stock structure, movements, and degree of mixing of these presumed stocks. As the research efforts are completed, it is likely that a number of stocks or communities will be identified, including year-round and resident stocks in embayments, and transient or migratory stocks. This will necessitate a revision of the stock assessment report of the western North Atlantic Coastal Stock of bottlenose dolphins to reflect the number of stocks described.

POPULATION SIZE

Mitchell (1975) estimated that the coastal bottlenose dolphin population which was exploited by a shore-based net fishery until 1925 (Mead 1975) numbered at least 13,748 bottlenose dolphins in the 1800s. Recent estimates of bottlenose dolphin abundance in the USA Atlantic coastal area were made from two types of aerial surveys. The first type was aerial survey using standard line transect sampling with perpendicular distance data analysis (Buckland *et al.* 1993) and the computer program DISTANCE (Laake *et al.* 1993). The alternate survey method consisted of a simple count of all bottlenose dolphins seen from aerial surveys within one km of shore.

An aerial line-transect survey was conducted during February-March 1992 in the coastal area south of Cape Hatteras. Sampling transects extended orthogonally from shore out to approximately 9 km past the western wall of the Gulf Stream into waters as deep as 140 m, and the area surveyed extended from Cape Hatteras to mid-Florida (Blaylock and Hoggard 1994). Systematic transects were placed randomly with respect to bottlenose dolphin distribution and approximately 3.3% of the total survey area of about 89,900 km² was visually searched. Survey transects, area, and dates were chosen utilizing the known winter distribution of the stocks in order to sample the entire coastal population; however, the offshore stock may represent some unknown proportion of the resulting population size estimates. Preliminary estimates of abundance were derived through the application of distance sampling analysis (Buckland *et al.* 1993) and the computer program DISTANCE (Laake *et al.* 1993) to the perpendicular distance sighting data. Bottlenose dolphin abundance was estimated to be 12,435 dolphins with coefficient of variation (CV) = 0.18 and the log-normal 95% confidence interval was 9,684-15,967 (Blaylock and Hoggard 1994).

An aerial survey was conducted during late January-early March 1995, following nearly the same design as the 1992 survey. Preliminary analysis (following the same procedures described above) resulted in an abundance estimate of 21,128 dolphins (CV=0.22) with a log-normal 95% confidence interval of 13,815-32,312.

Perpendicular sighting distance analysis (Buckland *et al.* 1983) of line transect data from an aerial survey throughout the northern portion of the range in July 1994, from Cape Hatteras to Sandy Hook, New Jersey, and from shore to the 25 m isobath, resulted in an abundance estimate of 25,841 bottlenose dolphins (CV=0.40) (Blaylock 1995) within the approximately 25,600 km² area. These data were collected during a pilot study for designing future surveys and are considered to be preliminary in nature.

An aerial survey of this area was conducted during mid July-mid August 1995. Data from the pilot study was used to design this survey; survey sampling was designed to produce an abundance estimate with a CV of 0.20 or less.

Preliminary analysis (following the same procedures described above for the surveys south of Cape Hatteras) resulted in an abundance estimate of 12,570 dolphins (CV=0.19) with a log-normal 95% confidence interval of 8,695-18,173.

An aerial survey of the coastal waters within a one km strip along the shore from Sandy Hook to approximately Vero Beach, Florida, was also conducted during July 1994 (Blaylock 1995). Dolphins from the offshore stock are believed unlikely to occur in this area. Observers counted all bottlenose dolphins seen within the one km strip alongshore from Cape Hatteras to Sandy Hook (northern area) and within the one km strip alongshore south of Cape Hatteras to approximately Vero Beach (southern area). The average of three counts of bottlenose dolphins in the northern area was 927 dolphins (range = 303-1,667) and the average of three counts of bottlenose dolphins in the southern area was 630 dolphins (range = 497-815). The sum of the highest counts in both areas was 2,482 dolphins.

A vessel survey to obtain abundance, distribution, and biopsy information from pelagic cetaceans in USA waters south of Delaware Bay was conducted during July and August 1998 (NMFS unpublished data). The survey included waters from approximately the 30 m isobath out to the offshore extent of the USA EEZ. A total of 56 herds or groups of bottlenose dolphins were sighted; an unknown number of these herds were likely the offshore bottlenose dolphin ecotype. One of the herds sighted was exceptionally large and was estimated to consist of 251 individuals. The data from the survey are currently being analyzed; abundance estimates should be available in late 1999.

It is not currently possible to distinguish the two bottlenose dolphin ecotypes with certainty during visual aerial and vessel surveys, as the distribution of the two ecotypes in USA Atlantic EEZ waters is uncertain. Because of this difficulty, the resulting abundance estimates may include dolphins from the offshore stock. Until additional research provides information to determine the range of habitat utilized by both ecotypes and their degree of mixing along the Atlantic coast, it will not be possible to assess the abundance of either type with any certainty. Determining the degree of geographic mixing of these two ecotypes is currently an active area of research by NMFS, SEFSC.

Minimum Population Estimate

Reasonable assurance of a minimum population estimate can not be provided by line transect surveys because the proportion of dolphins from the offshore stock which might have been observed is unknown. The risk averse approach is to assume that the minimum population size is the highest count of bottlenose dolphins within the one km strip from shore between Sandy Hook and Vero Beach obtained during the July 1994 survey. The maximum count within one km of shore between Sandy Hook and Cape Hatteras was 1,667 bottlenose dolphins and it was 815 bottlenose dolphins within one km of shore between Cape Hatteras and Vero Beach. The resulting minimum population size estimate for the western North Atlantic coastal bottlenose dolphin stock is 2,482 dolphins.

Current Population Trend

Kenney (1990) reported an estimated 400-700 bottlenose dolphins from the inshore strata of aerial surveys conducted along the USA Atlantic coast north of Cape Hatteras in the summer during 1979-1981. These estimates resulted from line transect analyses; thus, they cannot be used in comparison with the direct count data collected in 1994 to assess population trends.

There was no significant difference in bottlenose dolphin abundance estimated from aerial line transect surveys conducted south of Cape Hatteras in the winter of 1983 and the winter of 1992 using comparable survey designs (NMFS unpublished data; Blaylock and Hoggard 1994) in spite of the 1987-88 mortality incident during which it was estimated that the coastal migratory population may have been reduced by up to 53% (Scott *et al.* 1988).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock. The maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of the minimum population size, one-half the maximum productivity rate, and a "recovery" factor (Wade and Angliss 1997). The "recovery" factor, which accounts for endangered, depleted, and threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.50 because this stock is listed as depleted under the Marine Mammal Protection Act. Therefore, PBR for the USA Atlantic coastal bottlenose dolphin stock is 25 dolphins.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality or serious injury to this stock during 1994-1998 was 45.8 bottlenose dolphins (CV=0.67).

Fishery Information

Menhaden Purse Seine

The Atlantic menhaden purse seine fishery targets the Atlantic menhaden, *Brevortia tyrannus*, in Atlantic coastal waters approximately 3-18 m in depth. Twenty-two vessels operate off northern Florida to New England from April-January (NMFS 1991, pp. 5-73). Menhaden purse seiners have reported an annual incidental take of one to five bottlenose dolphins (NMFS 1991, pp. 5-73), although observer data are not available.

Mid-Atlantic Coastal Gillnet

Coastal gillnets operate in different seasons targeting different species in different states throughout the range of this stock. Most nets are anchored close to shore, but some are allowed to drift, and nets range in length from 91 m to 914 m. A gillnet fishery for American shad, *Alosa sapidissima*, operates seasonally from Connecticut to Georgia, with nets being moved from coastal ocean waters into fresh water with the shad spawning migration (Read 1994). It is considered likely that a few bottlenose dolphins are taken in this fishery each year (Read 1994). The portion of the fishery which operates along the South Carolina coast was sampled by observers during 1994 and 1995, and no fishery interactions were observed (McFee *et al.* 1996). The North Carolina sink gillnet fishery operates in October-May targeting weakfish, croaker, spot, bluefish, and dogfish. Another gillnet fishery along the North Carolina Outer Banks targets bluefish in January-March. Similar mixed-species gillnet fisheries, under state jurisdiction, operate seasonally along the coast from Florida to New Jersey, with the exclusion of Georgia.

The mid-Atlantic coastal gillnet fishery is actually a combination of small vessel fisheries that target a variety of fish species. Some of the fishery operates right off the beach. Although observer coverage of the fishery was initiated in July, 1993, there was no coverage in 1994 and bycatch estimates are available only for 1995-1998. Observer coverage of the fishery ranged from 3% in 1997 to 5% in 1995 and 1998. One take of a bottlenose dolphin was observed in 1995 and 1996, none in 1997, and three in 1998. The annual estimated mortalities with associated CVs in parentheses by year are as follows: 1995, 56 (1.66); 1996, 64 (0.83); 1997, 0; 1998, 63 (0.94); estimated 1995-1998 mean annual estimated take is 45.8, CV=0.67 (Table 2).

Shrimp Trawl

The shrimp trawl fishery operates from North Carolina through northern Florida virtually year around, moving seasonally up and down the coast. One bottlenose dolphin was recovered dead from a shrimp trawl in Georgia in 1995 (Southeast USA Marine Mammal Stranding Network unpublished data), but no bottlenose dolphin mortality or serious injury has been previously reported to NMFS.

Beach Seine

A beach seine fishery operates along northern North Carolina beaches during the spring and fall targeting mullet, spot, weakfish, sea trout, and bluefish. The North Carolina beach seine has been observed since April 7, 1998. The fishery, based on the Outer Banks of North Carolina, occurs primarily in the spring (April through June) and fall (October through December). This fishery has two types of setup systems: a "beach anchored gill net" and a "beach seine". Both systems utilize a gill net anchored to the beach. The beach seine system also uses a bunt and wash net that are attached to the beach and are in the surf. This fishery was observed by patrolling the beaches on a daily basis. During April 1998, 12 hauls were observed: 9 were the gill net system and 3 were the beach seine system. During May 1998, 26 hauls were observed: 14 gill net and 12 beach seine hauls. During October 1998, 7 hauls were observed, all the gill net system. During November 1998, 1 gillnet system haul was observed. During December 1998, 14 hauls were observed: 12 gill net and 2 beach seine hauls. The only observed take was a freshly killed bottlenose dolphin during May 1998. The beach seine observer data is currently being audited and is unavailable for analysis. The beach seine fishery bycatch mortality estimate will be available for the 2001 stock assessment report.

Table 2. Summary of the incidental mortality of bottlenose dolphins (*Tursiops truncatus*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type ¹	Observer Coverage ²	Observed Serious Injury	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Mid-Atlantic Coastal Sink Gillnet	94-98	NA	Obs. Data Weighout	NA, .05, .04, .03, .05	NA, 0, 0, 0, 0	NA, 1, 1, 0, 3	NA, 56, 64, 0, 63	NA, 1.66, .83, 0, .94	45.8 (0.67)
TOTAL									45.8 (0.67)

¹ Observer data (Obs. data) are used to measure bycatch rates; the USA data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. The NEFSC collects weighout (Weighout) landings data that are used as a measure of total effort for the USA sink gillnet fisheries.

² The observer coverage for the mid-Atlantic coastal sink gillnet fishery is measured in tons of fish landed.

Other Mortality

Bottlenose dolphins are known to interact with commercial fisheries and occasionally are taken in various kinds of fishing gear including gillnets, seines, long-lines, shrimp trawls, and crab pots (Read 1994, Wang *et al.* 1994) especially in near-shore areas where dolphin densities and fishery efforts are greatest. These interactions are due in part to the species' gregarious nature and habits of feeding on discarded bycatch and from baited gear (e.g., long-line and crab pots). However, stranding data probably underestimate the extent of fishery-related mortality and serious injury because not all of the dolphins which die or are seriously injured may wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery-interaction. In addition, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of fishery interaction. Due to the extent of decomposition and/or the level of experience of the examiner, a determination cannot always be made as to whether or not a stranding occurred due to human interaction.

From 1993-1997, two hundred and eighty-eight bottlenose dolphins were reported stranded in waters north of Cape Hatteras (Virginia to Massachusetts, NE Region) (NMFS, unpublished data). The majority of the strandings within this northern area occurred in Virginia (n = 182, 63%). An unknown number of the animals reported stranded during 1993-1995 have shown signs of entanglement with fishing gear or interactions with fishing activities; however, limited information was available for 1993, and complete information was available for 1996- 1999. In 1993, eight bottlenose dolphins in Virginia and one in Maryland were reported as entangled in fishing gear, but the gear type was not reported (NMFS unpublished data). In 1996, seventy-four bottlenose dolphins were reported stranded in the NE Region. The cause of death could be determined for 44 animals and of these, 16 or 36% were reported due to human interactions (including 13 gear entanglements). In 1997, seventy-four bottlenose dolphins were also reported stranded in the NE Region. The cause of death could be determined for 54 animals and of these, 14 or 26% were reported due to human interactions. If the percentages are consistent for animals for which cause of death could not be determined, it is likely that during 1996 about 27 (36%), and during 1997 about 19 (26%), of the stranded animals in the NE Region died due to human interactions.

Evidence of interaction with fisheries (entanglement, net marks, mutilations, gun shots, etc.) were present in 178 of 1353 of the bottlenose dolphin strandings investigated in the USA Southeast Atlantic region (North Carolina to Florida) from 1993 to 1998, (Table 3) as determined from evidence of entanglement in fishing gear and/or other human related causes (e.g., net marks, entanglement, mutilations, boat strikes, gunshot wounds) (NMFS unpublished information). This does not take into account those animals for which cause of death could not be determined so the number of animals that stranded due to human interaction is likely greater. Table 3 provides coastal bottlenose dolphin strandings observed from New York to Florida during 1997 through 1999 (unpublished data from Southeast and Northeast Marine Mammal Stranding Databases). This data is presently under analysis and additional information on

stock structure and fishery interactions is expected for the next Status of the Stocks review. As the table illustrates, there is considerable variability in strandings between these states during this time period.

North Carolina stranding records show the highest incidence of fishery interactions from the SE Atlantic Region. North Carolina data from 1993 through 1998 indicate that 120 of 489 animals, or 25% showed evidence of human interactions. In 1997, 127 123 bottlenose dolphin stranded in North Carolina. Cause of death could be determined for only 58 of these animals, and of these 36 or 62.1% exhibited positive signs of fisheries interactions. The results for 1998 were similar; of the 83 103 animals stranded, cause of death could be determined for only 35 and of these 19 or 54.3% exhibited positive signs of interactions. If this percentage is consistent for all North Carolina stranded animals, it is possible that approximately 78 or 62% of the stranded animals died from fisheries interactions in 1997, and in 1998 approximately 45 or 54% died from fisheries interactions.

In recent years reports of strandings with evidence of interactions between bottlenose dolphins and both recreational and commercial crab-pot fisheries have been increasing in the Southeast Region (McFee and Brooks 1998).

The nearshore habitat occupied by this stock is adjacent to areas of high human population and in the northern portion of its range is highly industrialized. The blubber of stranded dolphins examined during the 1987-88 mortality event contained anthropogenic contaminants in levels among the highest recorded for a cetacean (Geraci 1989). There are no estimates of indirect human-caused mortality resulting from pollution or habitat degradation, but a recent assessment of the health of live-captured bottlenose dolphins from Matagorda Bay, Texas, associated high levels of certain chlorinated hydrocarbons with low health assessment scores (Reif *et al.* in review).

STATUS OF STOCK

This stock is considered to be depleted relative to OSP and it is listed as depleted under the Marine Mammal Protection Act (MMPA). There are data suggesting that the population was at an historically high level immediately prior to the 1987-88 mortality event (Keinath and Musick 1988); however, the 1987-88 anomalous mortality event was estimated to have decreased the population by as much as 53% (Scott *et al.* 1988). A comparison of historical and recent winter aerial survey data in the area south of Cape Hatteras found no statistically significant difference between population size estimates (Student's t-test, $P > 0.10$), but these estimates may have included an unknown proportion of the offshore stock. Population trends cannot be determined due to insufficient data.

Although there are limited observer data directly linking serious injury and mortality to fisheries (e.g., in the

Table 3. Bottlenose dolphin strandings from New York to Florida during 1997 through 1999. Data from Southeast and Northeast Marine Mammal Stranding Databases.

STATE	1997	1998	1999
NEW YORK Total Stranded	2	3	3
Human Interaction			
---- Fishery Interaction	1	0	0
---- Mutilation	0	0	0
---- Other	0	0	0
No Human Interaction	0	2	3
Could Not Be Determined	1	1	0
NEW JERSEY Total Stranded	10	11	15
Human Interaction			
---- Fishery Interaction	0	1	3
---- Mutilation	0	0	0
---- Other	0	0	0
No Human Interaction	2	3	2
Could Not Be Determined	8	7	10
DELAWARE Total Stranded	14	8	18
Human Interaction			
--- Fishery Interaction	1	1	1
--- Mutilation	0	0	0
---- Other	2	1	0
No Human Interaction	4	0	4
Could Not Be Determined	7	6	13
MARYLAND Total Stranded	2	2	2
Human Interaction			
---- Fishery Interaction	0	0	1
---- Mutilation	0	0	0
---- Other	0	0	0
No Human Interaction	1	0	1
Could Not Be Determined	1	2	3
VIRGINIA Total Stranded	44	42	50
Human Interaction			
---- Fishery Interaction	11	8	18
---- Mutilation	0	2	3
---- Other	0	1	0
No Human Interaction	15	12	6
Could Not Be Determined	18	19	23
N. CAROLINA Total Stranded	123	103	94
Human Interaction			
---- Fishery Interaction	28	22	24
---- Mutilation	5	3	1
---- Other	1	0	0
No Human Interaction	21	16	19
Could Not Be Determined	68	62	50
S. CAROLINA Total Stranded	41	41	34
Human Interaction			
---- Fishery Interaction	8	4	1
---- Mutilation	2	0	1
---- Other	0	1	2
No Human Interaction	15	10	10
Could Not Be Determined	16	26	20
GEORGIA Total Stranded	18	26	14
Human Interaction			
---- Fishery Interaction	1	1	1
---- Mutilation	0	0	0
---- Other	0	0	0
No Human Interaction	8	6	8
Could Not Be Determined	9	19	5
FLORIDA Total Stranded	104	80	87
Human Interaction			
---- Fishery Interaction	7	3	4
---- Mutilation	0	0	0
---- Other	0	1	0
No Human Interaction	34	29	28
Could Not Be Determined	63	47	55

coastal gillnet fishery complex in the mid-Atlantic), the total number of bottlenose dolphin assumed from this stock which stranded showing signs of fishery or human-related mortality exceeded PBR in 1993, 1996, 1997, and by the end of October in 1998. In North Carolina alone, human-related mortality approached PBR in each of the intervening years. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR, and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate.

The species is not listed as threatened or endangered under the Endangered Species Act, but because this stock is listed as depleted under the MMPA it is a strategic stock.

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COMMON DOLPHIN (*Delphinus delphis*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The common dolphin may be one of the most widely distributed species of cetaceans, as it is found world-wide in temperate, tropical, and subtropical seas. In the North Atlantic, common dolphin appear to be present along the coast over the continental shelf along the 200-300 m isobaths or over prominent underwater topography from 50° N to 40° S latitude (Evans 1994). The species is less common south of Cape Hatteras, although schools have been reported as far south as eastern Florida (Gaskin 1992). At least some of the reported sightings of common dolphins in the Gulf of Mexico may have been *Stenella clymene*, which has a color pattern similar to that of common dolphins (Evans 1994). Information regarding common dolphin stock structure in the western North Atlantic does not exist. However, a high variance in skull morphometric measurements suggests the existence of more than a single stock (J. G. Mead, pers. comm.).

Common dolphins are distributed along the continental slope (100 to 2,000 meters), and are associated with Gulf Stream features in waters off the northeastern USA coast (CETAP 1982; Selzer and Payne 1988; Waring *et al.* 1992). They are widespread from Cape Hatteras northeast to Georges Bank (35° to 42° North latitude) in outer continental shelf waters from mid-January to May (Hain *et al.* 1981; CETAP 1982; Payne *et al.* 1984). Common dolphins move northward onto Georges Bank and the Scotian Shelf from mid-summer to autumn (Palka *et al.* in review). Selzer and Payne (1988) reported very large aggregations (greater than 3,000 animals) on Georges Bank in autumn. Common dolphins are rarely found in the Gulf of Maine, where temperature and salinity regimes are lower than on the continental slope of the Georges Bank/mid-Atlantic region (Selzer and Payne 1988). Migration onto the Scotian Shelf and continental shelf off Newfoundland occurs during summer and autumn when water temperatures exceed 11°C (Sergeant *et al.* 1970; Gowans and Whitehead 1995).

POPULATION SIZE

Total numbers of common dolphins off the USA or Canadian Atlantic coast are unknown, although five estimates from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). An abundance of 29,610 common dolphins (CV=0.39) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental, shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (CETAP 1982). An abundance of 22,215 (CV=0.40) common dolphins was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Waring *et al.* 1992; Waring 1998). As recommended in the GAMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

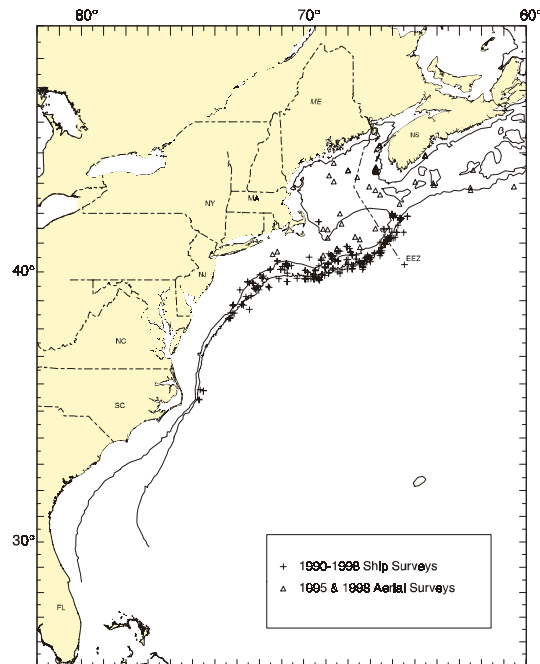


Figure 1. Distribution of common dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and 1,000 m.

An abundance of 1,645 (CV=0.47) common dolphins was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for $g(0)$ or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of 6,741 (CV=0.69) common dolphins was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; Palka *et al.* in review). Total track line length was 32,600 km. The ships covered waters between the 50 and 1000 fathom depth contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the mid-Atlantic from the coastline to the 50 fathom depth contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom depth contour line. Data collection and analysis methods used were described in Palka (1996).

An abundance of 30,768 (CV=0.32) for common dolphins was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900 km of track line in waters north of Maryland (38°N) (Figure 1; Palka *et al.* in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

No common dolphins were encountered during the SEFSC component of the joint surveys. That shipboard line transect sighting survey was conducted between 8 July and 17 August 1998 and surveyed 5,570 km of track line in waters south of Maryland (38°N) (Mullin in review).

Although the 1991, 1993, 1995, and 1998 surveys did not sample the same areas or encompass the entire common dolphin habitat (e. g., little effort in Scotian shelf edge waters), they did focus on segments of known or suspected high-use habitats off the northeastern USA coast. The 1993, 1995, and 1998 data suggest that, seasonally, at least several thousand common dolphins are occupying continental shelf edge waters, with perhaps highest abundance in the Georges Bank region.

The best available abundance estimate for common dolphins is 30,768 (CV=0.32) as estimated from the July 6 to September 6, 1998 USA Atlantic surveys. This estimate is considered best because these surveys have the most complete coverage of the species' habitat. The previous best estimate of 22,215 (CV=0.40) is nearly eight years old.

Table 1. Summary of abundance estimates for western North Atlantic common dolphin. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	1,645	0.47
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	6,741	0.69
Jul-Sep 1998	Maryland to Gulf of St. Lawrence	30,768	0.32

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for common dolphins is 30,768 (CV=0.32). The minimum population estimate for the western North Atlantic common dolphin is 23,655 (CV=0.32).

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that

cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 23,655 (CV=0.32). The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.48 because the CV of the average mortality estimate is between 0.3-0.6 (Wade and Angliss 1997), and because this stock is of unknown status. PBR for the western North Atlantic common dolphin is 227.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality or serious injury to this stock during ~~1994-1998~~ 1995-1999 was ~~612406~~ common dolphins CV=~~0.40~~0.45; Table 2).

Fishery Information

USA

Prior to 1977, there was no documentation of marine mammal bycatch in distant-water fleet (DWF) activities off the northeast coast of the USA. With implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA), an observer program was established which has recorded fishery data and information of incidental bycatch of marine mammals. DWF effort in the Atlantic coast Exclusive Economic Zone (EEZ) under MFCMA has been directed primarily towards Atlantic mackerel and squid. From 1977 through 1982, an average of 120 different foreign vessels per year (range 102-161) operated within the Atlantic coast EEZ. In 1982, there were 112 different foreign vessels; 16%, or 18, were Japanese tuna longline vessels operating along the USA east coast. This was the first year that the Northeast Regional Observer Program assumed responsibility for observer coverage of the longline vessels. Between 1983 and 1991, the numbers of foreign vessels operating within the Atlantic coast EEZ each year were 67, 52, 62, 33, 27, 26, 14, 13, and 9, respectively. Between 1983 and 1988, the numbers of DWF vessels included 3, 5, 7, 6, 8, and 8, respectively, Japanese longline vessels. Observer coverage on DWF vessels was 25-35% during 1977-82, and increased to 58%, 86%, 95%, and 98%, respectively, in 1983-86. From 1987-91, 100% observer coverage was maintained. Foreign fishing operations for squid and mackerel ceased at the end of the 1986 and 1991 fishing seasons, respectively.

During the period 1977-1986, observers recorded 123 mortalities in foreign *Loligo* squid-fishing activities (Waring *et al.* 1990). In 1985 and 1986, Italian vessels took 56 and 54 animals, respectively, which accounts for 89% (n = 110) of the total takes in foreign *Loligo* squid-fishing operations. No mortalities were reported in foreign *Illex* squid fishing operations. Because of spatial/temporal fishing restrictions, most of the bycatch occurred along the continental shelf edge (100 m) isobath during winter (December to February).

From 1977-1991, observers recorded 110 mortalities in foreign mackerel-fishing operations (Waring *et al.* 1990; NMFS unpublished data). This total includes one documented take by a USA vessel involved in joint-venture fishing operations in which USA captains transfer their catches to foreign processing vessels. The bycatch occurred during winter/spring (December to May).

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet, pelagic pair trawl, pelagic longline fishery, mid-Atlantic coastal gillnet, North Atlantic bottom trawl, Northeast multispecies sink gillnet, and Atlantic squid, mackerel, butterfish trawl fisheries.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991,

1992, 1993, 1994, 1995, 1996, and 1998 were 233, 243, 232, 197, 164, 149, and 113 respectively. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (*i.e.*, permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. ~~Since~~ **From** 1994-1998, between 10 and 13 vessels have participated in the fishery (~~Table 2~~). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, 64% in 1996, and 99% in 1998. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fisheries information. Variances were estimated using bootstrap re-sampling techniques. Eight hundred and sixty-one common dolphin mortalities were observed between 1989 and 1998 in this fishery. Mortalities were observed in all seasons and areas. Seven animals were released alive, but six were injured. Estimated annual mortality and serious injury attributable to this fishery (CV in parentheses) was 540 in 1989 (0.19), 893 in 1990 (0.18), 223 in 1991 (0.12), 227 in 1992 (0.09), 238 in 1993 (0.08), 163 in 1994 (0.02), 83 in 1995 (0), 106 in 1996 (0.07), and 255 in 1998 (0). ~~The 1994-1998 average mortality for this fishery was 4.1 (CV=0.01) (Table 2).~~ **Since this fishery no longer exists, it has been excluded from Tables 2 and 3 (see Waring *et al.* 1999).**

Pelagic Pair Trawl

During the period 1989 to 1993, effort in the pelagic pair trawl fishery increased from zero hauls in 1989 and 1990, to an estimated 171 hauls in 1991 and then to an estimated 536 hauls in 1992 and 586 in 1993, 407 in 1994 and 440 in 1995. This fishery ceased operations in 1996, when NMFS rejected a petition to consider pair trawl gear as an authorized gear type in Atlantic tunas fishery. The fishery operated from August to November in 1991, from June to November in 1992, from June to October in 1993 (Northridge 1996), and from mid-summer to December in 1994 & 1995. Sea sampling began in October of 1992 (Gerrior *et al.* 1994) where 48 sets (9% of the total) were sampled. In 1993, 102 hauls (17% of the total) were sampled. In 1994 and 1995, 52% (212) and 55% (238), respectively, of the sets were observed. Nineteen vessels have operated in this fishery. The fishery operates in the area between 35°N to 41°N and 69°W to 72°W. Approximately 50% of the total effort was within a one degree square at 39°N, 72°W, around Hudson Canyon from 1991 to 1993. Examination of the (1991-1993) locations and species composition of the bycatch, showed little seasonal change for the six months of operation and did not warrant any seasonal or areal stratification of this fishery. Twelve mortalities were observed between 1991 and 1995. The estimated annual fishery-related mortality and serious injury attributable to this fishery (CV in parentheses) was 5.6 in 1991 (0.53), 32 in 1992 (0.48), 35 in 1993 (0.43), 0 in 1994 (0), and 5.6 in 1995 (0.35). Since this fishery no longer in operation it has been deleted from Table 2. During the 1994 and 1995 experimental pelagic pair trawl fishing seasons, fishing gear experiments were conducted to collect data on environmental parameters, gear behavior, and gear handling practices to evaluate factors affecting catch and bycatch (Goudey 1995, 1996). Results of these studies have been presented at Offshore Cetacean Take Reduction Team Meetings.

Pelagic Longline

~~The pelagic longline fishery operates in the USA Atlantic (including Caribbean) and Gulf of Mexico EEZ (SEFSC unpublished data). Interactions between the pelagic longline fishery and pilot whales have been reported; however, a vessel may fish in more than one statistical reporting area and it is not possible to separate estimates of fishing effort other than to subtract Gulf of Mexico effort from Atlantic fishing effort, which includes the Caribbean Sea. This fishery has been monitored with about 5% observer coverage, in terms of trips observed, since 1992. Total effort, excluding the Gulf of Mexico, for the pelagic longline fishery, based on mandatory self-reported fisheries information, was 11,279 sets in 1991, 9,869 sets in 1992, 9,862 sets in 1993, 9,481 sets in 1994, 10,129 sets in 1995, 9,885 sets in 1996, 8,023 sets in 1997, and 6,675 sets in 1998 (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999; Yeung 1999a).~~

Total effort, excluding the Gulf of Mexico **and fishing regions east of 60°W longitude**, for the pelagic longline fishery, based on mandatory self-reported fisheries information, was 11,279 sets in 1991, ~~9,869~~ **8,579** sets in 1992, ~~9,862~~ **8,644** sets in 1993, ~~9,481~~ **9,191** sets in 1994, ~~10,129~~ **9,124** sets in 1995, ~~9,885~~ **7,818** sets in 1996, ~~8,023~~ **7,707** sets in 1997, ~~and 6,675~~ **6,305** sets in 1998, **and 5,832 sets in 1999** (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999;

Yeung 1999a; Yeung *et al.* 2000). Since 1992, this fishery has been monitored with about 5% observer coverage, in terms of trips observed, within every statistical reporting area within the EEZ and beyond. Off the USA Atlantic coast, the fishery has been observed from January to March off Cape Hatteras, in May and June in the entire mid-Atlantic, and in July through December in the mid-Atlantic Bight and off Nova Scotia. This fishery has been monitored with about 5% observer coverage, in terms of trips observed, since 1992. The 1994-1998, estimated take was based on a revised analysis of the observed incidental take and self-reported incidental take and effort data, and replace previous estimates for the 1992-1993 and 1994-1995 periods (Cramer 1994; Scott and Brown 1997; Johnson *et al.* 1999). Further, Yeung (1999b), revised the 1992-1997 fishery mortality estimates in Johnson *et al.* (1999) to include seriously injured animals. The 1998 bycatch estimates were from Yeung (1999a). Most of the estimated marine mammal bycatch was from EEZ waters between South Carolina and Cape Cod (Johnson *et al.* 1999). Between 1990-1998 ~~one~~ **one** common dolphins ~~was~~ **were** hooked and released alive (Yeung *et al.* 2000).

Northeast Multispecies Sink Gillnet

In 1993, there were approximately 349 full and part-time vessels in the Northeast multispecies sink gillnet fishery, which covered the Gulf of Maine and southern New England (Table 2). An additional 187 vessels were reported to occasionally fish in the Gulf of Maine with gillnets for bait or personal use; however, these vessels were not covered by the observer program (Walden 1996) and their fishing effort was not used in estimating mortality. Observer coverage in terms of trips has been 1%, 6%, 7%, 5%, 7%, 5%, 4%, 6%, ~~and 5%, and 6%~~ for 1990 to ~~1998~~ **1999**, respectively. The fishery has been observed in the Gulf of Maine and in Southern New England. In 1996, the first observed mortality of common dolphins in this fishery was recorded. The estimated annual fishery-related mortality and serious injury attributable to this fishery (CV in parentheses) was The estimated mortality was 0 in 1995 (0), 63 in 1996 (CV=1.39), **0 in 1997 (0), 0 in 1998 (0) and 146 in 1999 (.97)**; estimated annual mortality (~~1994-1998~~ **1995-1999**) was ~~12.6~~ **42** common dolphins (CV=~~1.39~~ **0.78**) (Table 2). Annual estimates of common dolphin bycatch in the Northeast multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort.

Mid-Atlantic Coastal Gillnet

Observer coverage of the USA Atlantic coastal gillnet fishery was initiated by the NEFSC Sea Sampling program in July, 1993; and from July to December 1993, 20 trips were observed. During 1994 and 1995 221 and 382 trips were observed, respectively. This fishery, which extends from North Carolina to New York, is actually a combination of small vessel fisheries that target a variety of fish species, some of which operate right off the beach. The number of vessels in this fishery is unknown, because records which are held by both state and federal agencies have not been centralized and standardized. Observer coverage, expressed as percent of tons of fish landed, was 5%, 4%, 3%, ~~and 5%, and 2%~~ for 1995, 1996, 1997, ~~and 1998, and 1999~~ (Table 2).

No common dolphins were taken in observed trips during 1993 and 1994. Two common dolphin were observed taken in 1995, 1996, and 1997, and no takes were observed in 1998 ~~and 1999~~ (Table 2). Observed effort was concentrated off NJ and scattered between DE and NC from 1 to 50 miles off the beach. All bycatches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 7.4 in 1995 (CV=0.69), 43 in 1996 (0.79), 16 in 1997 (0.53), and 0 in 1998-~~1999~~. Average annual estimated fishery-related mortality attributable to this fishery during ~~1995-1998~~ **1995-1999** was ~~16.5~~ **13** common dolphins (CV=~~0.53~~ **0.53**)

North Atlantic Bottom Trawl

Vessels in the North Atlantic bottom trawl fishery, a Category III fishery under MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. An average of 970 vessels (full and part time) participated annually in the fishery during 1991-1995. The fishery is active in all seasons in New England waters. Four mortalities were observed between 1991- 1998. Observer coverage, expressed as number of trips, was < 1% from 1994-1998 (Table 2). The estimated annual fishery-related mortality and serious injury attributable to this fishery (CV in parentheses) was 0 in 1991, 0 in 1992, 0 in 1993, 0 in 1994 (0), 142 in 1995 (0.77), 0 in 1996 (0), 93 in 1997 (1.06), and 0 in 1998 ~~and 1999~~. Average annual estimated fishery-related mortality attributable to this fishery during ~~1994-1998~~ **1995-1999** was ~~47~~ **47** common dolphins (CV=~~0.63~~ **0.63**) (Table 2). However, these estimates should be viewed with caution due to the extremely low (<1%) observer coverage.

Squid, Mackerel, Butterfish Trawl

The mid-Atlantic mackerel and squid trawl fisheries were combined into the Atlantic mid-water trawl fishery in the revised proposed list of fisheries in 1995. The fishery occurs along the USA mid-Atlantic continental shelf region between New Brunswick, Canada, and Cape Hatteras year around. The mackerel trawl fishery was classified as a

Category II fishery since 1990 and the squid fishery was originally classified as a Category II fishery in 1990, but was reclassified as a Category III fishery in 1992. The combined fishery was reclassified as a Category II fishery in 1995. In 1996, mackerel, squid, and butterfish trawl fisheries were combined into the Atlantic squid, mackerel, and butterfish trawl fishery, and maintained a Category II classification. Observer coverage, expressed as number of trips, was < 1% from 1996-1998 ~~1999~~ (Table 2). Three common dolphin mortalities were observed in 1996, one in 1997, ~~and zero in 1998, one in 1999~~ (Table 2). The 1996 mortalities were in the Loligo squid fishery and the 1997 mortality occurred in the Atlantic mackerel fishery. The estimated annual fishery-related mortality and serious injury attributable to this fishery (CV in parentheses) was 940 in 1996 (0.75), 161 in 1997 (0.49), ~~and 0 in 1998, and 49 in 1999 (.78)~~. Average annual estimated fishery-related mortality attributable to this fishery during ~~1996-1998~~ ~~1996-1999~~ was ~~367~~ ~~287~~ common dolphins (CV=~~0.64~~ ~~0.62~~) (Table 2). However, these estimates should be viewed with caution due to the extremely low (<1%) observer coverage and uncertainties regarding number of vessels participating in this "fishery".

Mackerel Joint Venture

A USA joint venture fishery was conducted in the mid-Atlantic region from February-May 1998. NMFS, maintained 100% observer coverage on the foreign joint venture vessels. One hundred and fifty-two transfers from the USA vessels were observed. Seventeen common dolphin mortalities were observed in March. The principal fish species in the transferred trawl nets and number of bycaught animals (in parentheses) were: squid (11), butterfish (4), and mackerel (2). Average annual estimated fishery-related mortality attributable to this fishery in 1998 was 17 common dolphins (CV=0) (Table 2).

CANADA

Between January 1993 and December 1994, 36 Spanish deep water trawlers, covering 74 fishing trips (4,726 fishing days and 14,211 sets), were observed in NAFO Fishing Area 3 (off the Grand Bank) (Lens 1997). A total of 47 incidental catches were recorded, which included one common dolphin. The incidental mortality rate for common dolphins was 0.007/set.

Table 2. Summary of the incidental mortality of common dolphins (*Delphinus delphis*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type ¹	Observed Serious Injury	Observer Coverage ²	Observed Mortality	Estimated Mortality ⁵	Estimated CVs	Mean Annual Mortality
Pelagic Drift Gillnet⁶	94-98	1994=11 1995=12 1996=10 1998=13	Obs. Data Logbook	0, 0, 0, 0; 0	.87, .99, .64, NA, .99	142, 82, 74, NA, 255	238, 163, 83³, 106, NA, 255	.08, .02, 0, .07, NA, 0	151.8⁸ (0.01)
Northeast Multispecies Sink Gillnet	94-98 95-99	349	Obs. Data Weighout, Logbooks	0, 0, 0, 0, 0	.07, .05, .04, .06, .05, .06	0, 0, 1, 0, 0, 2	0, 0, 63, 0, 0, 146	0, 0, 1.39, 0, 0 .97	12.6 (1.39) 42 (.78)
Mid-Atlantic Coastal Gillnet	94-98 95-99	NA	Obs. Data Weighout	0, 0, 0, 0, 0	.05, .04, .03, .05, .02	2, 2, 2, 0, 0	7.4, 43, 16, 0, 0	.69, .79, .53, 0, 0	16.5 (0.53) 13 (.53)
Atlantic squid, mackerel, butterfish trawl	96-98 99	NA	Obs. Data Weighout	0, 0, 0, 0	.007, .008, .003, .004	3 ⁴ ⁷ , 1 ⁴ ⁷ , 0, 1 ⁴	940, 161, 0, 49	.75, .49, 0, .78	367 (0.64) 287 (.62)

Fishery	Years	Vessels	Data Type ¹	Observed Serious Injury	Observer Coverage ²	Observed Mortality	Estimated Mortality ⁵	Estimated CVs	Mean Annual Mortality
North Atlantic Bottom Trawl	94-98 95-99	970	Obs. Data Weighout	0, 0, 0, 0, 0	.004, .011- ³ , .002, .002, .001, .003	0, 3, 0, 1, 0, 0	0, 142, 0, 93, 0, 0	0, .77, 0, 1.06, 0, 0	47 (.63)
Mackerel joint venture	98	4	Obs. Data	0	1.00	17	17	0	17 (0)
TOTAL									-612 -(0.40) 406 (.45)

¹ Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects ~~weighout (Weighout)~~ landings data (Weighout), and total landings are used as a measure of total effort for the coastal gillnet fishery and days fished are used as total effort for the North Atlantic bottom trawl fishery. ~~Mandatory logbook (Logbook) data are used to measure total effort for the pelagic drift gillnet fishery, and these data are collected at the Southeast Fisheries Science Center (SEFSC).~~

² The observer coverage for the pelagic drift gillnet and pair trawl fishery is measured in terms of sets, and the North Atlantic bottom trawl fishery is in trips. ~~Assessments for the coastal gillnet fishery have not been completed. The number of trips sampled by the NEFSC Sea Sampling Program are reported here.~~

³ ~~One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 7.0 animals. However, the SEFSC mandatory logbook data was taken at face value, and therefore it was assumed that 1 set was fished within this trip, and the point estimate would then increase by 0.50 animals.~~

⁴ ~~Observer coverage for the North Atlantic bottom trawl fishery in 1995 is based on January to May data.~~

⁵ ~~Seriously injured and released alive animals are included in the Table 2 mortality estimates.~~

⁶ ~~The fishery did not operate in 1997; the average annual mortality is based on the number of years (4;) that the fishery operated.~~

⁷ ~~4 In During 1996 and 1999 and 1997 the observed common dolphins were taken in the *Loligo* squid and Atlantic mackerel otter trawl subfisheries, and during 1997 the observed common dolphin was taken in the Atlantic mackerel otter trawl subfishery. respectively.~~

Other Mortality

From 1992-1998, 94 common dolphins were stranded between North Carolina and Massachusetts, predominantly along beaches in the latter state (NMFS unpublished data). The total includes ten and nine common dolphins that, respectively mass stranded in November 1997 and January 1998 on Cape Cod.

~~Three~~Four common dolphin strandings (6 individuals) were reported on Sable Island, Nova Scotia from ~~1990-1996~~1970-1998, and all strandings have occurred since 1996 (Lucas and Hooker 1997; Lucas and Hooker 2000.)).

STATUS OF STOCK

The status of common dolphins, relative to OSP, in the USA Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine the population trends for this species. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because the ~~1994-1998~~1995-1999 average annual fishery-related mortality and serious injury exceeds PBR.

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HARBOR PORPOISE (*Phocoena phocoena*): Gulf of Maine/Bay of Fundy Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

This stock is found in USA and Canadian Atlantic waters. The distribution of harbor porpoises has been documented by sighting surveys, strandings, and takes reported by NMFS observers in the Sea Sampling Program. During summer (July to September), harbor porpoises are concentrated in the northern Gulf of Maine and southern Bay of Fundy region, generally in waters less than 150 m deep (Gaskin 1977; Kraus *et al.* 1983; Palka 1995a, b), **with a few sightings in the upper Bay of Fundy and on the northern edge of Georges Bank (Palka 2000)**. During fall (October–December) and spring (April–June), harbor porpoises are widely dispersed from New Jersey to Maine, with lower densities farther north and south. They are seen from the coastline to deep waters (> 1800 m; Westgate *et al.* 1998), although the majority of the population is found over the continental shelf. During winter (January to March), intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina, and lower densities are found in waters off New York to New Brunswick, Canada. There does not appear to be a temporally coordinated migration or a specific migratory route to and from the Bay of Fundy region. Though, during the fall, several satellite tagged harbor porpoises did favor the waters around the 92m isobath, which is consistent with observations of high rates of incidental catches in this depth range (Read and Westgate 1997). There were two stranding records from Florida (Smithsonian strandings data base).

Gaskin (1984, 1992) proposed that there were four separate populations in the western North Atlantic: the Gulf of Maine/Bay of Fundy, Gulf of St. Lawrence, Newfoundland and Greenland populations. Recent analyses involving mtDNA (Wang *et al.* 1996; Rosel *et al.* 1999a; Rosel *et al.* 1999b), organochlorine contaminants (Westgate *et al.* 1997; Westgate and Tolley 1999), heavy metals (Johnston 1995), and life history parameters (Read and Hohn 1995) support Gaskin's proposal. Genetic studies using mitochondrial DNA (Rosel *et al.* 1999a) and contaminant studies using total PCBs (Westgate and Tolley 1999) indicate that the Gulf of Maine/Bay of Fundy females were distinct from females from the other populations in the NW Atlantic. Gulf of Maine/Bay of Fundy males were distinct from Newfoundland and Greenland males, but not from Gulf of St. Lawrence males according to studies comparing mtDNA (Rosel *et al.* 1999a; Palka *et al.* 1996) and CHLORs, DDTs, PCBs and CHBs (Westgate and Tolley 1999). Analyses of stranded animals from the mid-Atlantic states suggest that this aggregation of harbor porpoises consists of animals from more than just the Gulf of Maine/Bay of Fundy stock (Rosel *et al.* 1999). However, the majority of the samples used in the Rosel *et al.* (1999a) study were from stranded juvenile animals. Further work is underway to examine adult animals from this region. Nuclear microsatellite markers have also been applied to samples from these four populations, but this analysis failed to detect significant population subdivision in either sex (Rosel *et al.* 1999a). This pattern may be indicative of female philopatry coupled with dispersal of male harbor porpoises. This report follows Gaskin's hypothesis on harbor porpoise stock structure in the western North Atlantic; Gulf of Maine and Bay of Fundy

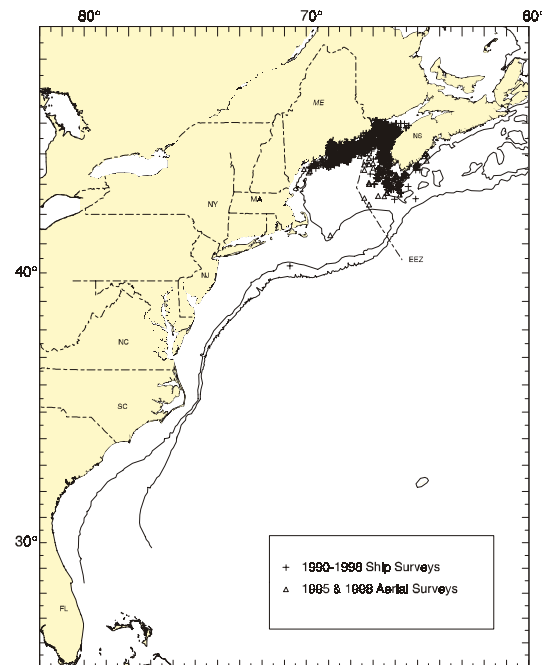


Figure 1. Distribution of harbor porpoise sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and 1,000 m.

harbor porpoises are recognized as a single management stock separate from harbor porpoise populations in the Gulf of St. Lawrence, Newfoundland, and Greenland.

POPULATION SIZE

To estimate the population size of harbor porpoises in the Gulf of Maine/Bay of Fundy region, ~~four~~three line-transect sighting surveys were conducted during the summers of 1991, 1992, ~~and 1995~~, and 1999 (Table 1; Figure 1). The population sizes were 37,500 harbor porpoises in 1991 (CV=0.29, 95% confidence interval (CI) = 26,700-86,400) (Palka 1995a), 67,500 harbor porpoises in 1992 (CV=0.23, 95% CI = 32,900-104,600), ~~and~~ 74,000 harbor porpoises in 1995 (CV=0.20, 95% CI = 40,900-109,100) (Palka 1996), and 89,700 (CV=0.22, 95% CI = 53,400 - 150,900) (Palka 2000). The inverse variance weighted-average abundance estimate (Smith *et al.* 1993) of the 1991 to 1995 estimates was 54,300 harbor porpoises (CV=0.14, 95% CI = 41,300-71,400). Possible reasons for inter-annual differences in abundance and distribution include experimental error, ~~between~~ inter-annual changes in water temperature and availability of primary prey species (Palka 1995b), and movement among population units (e.g., between the Gulf of Maine and Gulf of St. Lawrence). ~~One of the reasons the 1999 estimate is larger than previous estimates is the upper Bay of Fundy and northern Georges Bank were surveyed only in 1999 and harbor porpoises were seen. Thus, the habitat is larger than previously thought (Palka 2000).~~

The shipboard sighting survey procedure used in all ~~four~~three surveys involved two independent teams on one ship that searched using the naked eye in non-closing mode. Abundance, corrected for $g(0)$, the probability of detecting an animal group on the track line, was estimated using the direct-duplicate method (Palka 1995a) and variability was estimated using bootstrap re-sampling methods. Potential biases not explicitly accounted for are ship avoidance and submergence time. ~~The effects of these two potential biases are unknown.~~ During 1995 and 1999 a section of the region was surveyed by airplane while the rest of the region was surveyed by ship, as in previous years. The 1995 and 1999 abundance estimate, including $g(0)$, was estimated for both the plane and ship (Palka 1996; 2000). During 1995, in addition to the Gulf of Maine/Bay of Fundy area, waters from Virginia to the mouth of the Gulf of St. Lawrence were surveyed and ~~no~~ harbor porpoises were seen ~~only~~except in the vicinity of the Gulf of Maine/Bay of Fundy. ~~During 1999, waters from south of Cape Cod to the mouth of the Gulf of St. Lawrence were surveyed (Palka 2000).~~

~~The best current abundance estimate of the Gulf of Maine/Bay of Fundy harbor porpoise stock is 89,700 (CV=0.22), this is the 1999 survey results not averaged with other years. This is because the 1999 estimate is the most current, and this survey discovered portions of the harbor porpoise range not covered in previous years.~~

Kingsley and Reeves (1998) estimated there were 12,100 (CV=0.26) harbor porpoises in the entire Gulf of St. Lawrence during 1995 and 21,700 (CV=0.38) in the northern Gulf of St. Lawrence during 1996. These estimates are presumed to be of the Gulf of St. Lawrence stock of harbor porpoises. The highest densities were north of Anticosti Island, with lower densities in the central and southern Gulf. During the 1995 survey, 8,427 km of track lines were flown in an area of 221,949 km² during August and September. During the 1996 survey, 3,993 km of track lines were flown in an area of 94,665 km² during July and August. Data were analyzed using Quenouille's jackknife bias reduction procedure on line transect methods that modeled the left truncated sighting curve. These estimates were not corrected for visibility biases, such as $g(0)$.

Table 1. Summary of abundance estimates for the Gulf of Maine/Bay of Fundy harbor porpoise ~~for the entire area that was surveyed and a common area that was surveyed in all years.~~ Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	Entire survey area		Common survey area
		N_{best}	CV	N
Jul-Aug 1991	N. Gulf of Maine & lower Bay of Fundy	37,500	0.29	29,000
Jul-Sep 1992	N. Gulf of Maine & lower Bay of Fundy	67,500	0.23	57,600

Month/Year	Area	Entire survey area		Common survey area
		N _{best}	CV	N
Jul-Sep 1995	N. Gulf of Maine & lower Bay of Fundy	74,000	0.20	71,900
Inverse variance-weighted average of above 1991, 1992 and 1995 estimates		54,300	0.14	-
Jul-Aug 1999	S. Gulf of Maine to upper Bay of Fundy	89,700	0.22	67,600

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for harbor porpoises is **89,700 (CV=0.22)** ~~54,300 (CV=0.14)~~. The minimum population estimate for the Gulf of Maine/Bay of Fundy harbor porpoise is **74,695 (CV=0.22)** ~~48,289 (CV=0.14)~~.

Current Population Trend

Analyses are underway to determine if trend information can be obtained from the four NEFSC surveys. ~~There are insufficient data to determine the population trends for this species.~~ Previous abundance estimates for harbor porpoises in the Gulf of Maine/Bay of Fundy are available from earlier studies, (e. g. 4,000 animals, Gaskin 1977, and 15,800 animals, Kraus *et al.* 1983). These estimates cannot be used in a trends analysis because they were for selected small regions within the entire known summer range and, in some cases, did not incorporate an estimate of g(0) (NEFSC 1992).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Although current population growth rates of Gulf of Maine/Bay of Fundy harbor porpoises have not been estimated due to lack of data, several attempts have been made to estimate potential population growth rates. Barlow and Boveng (1991), who used a re-scaled human life table, estimated the upper bound of the annual potential growth rate to be 9.4%. Woodley and Read (1991) used a re-scaled Himalayan tahr life table to estimate a likely annual growth rate of 4%. In an attempt to estimate a potential population growth rate that incorporates many of the uncertainties in survivorship and reproduction, Caswell *et al.* (1998) used a Monte Carlo method to calculate a probability distribution of growth rates. The median potential annual rate of increase was approximately 10%, with a 90% confidence interval of 3-15%. This analysis underscored the considerable uncertainty that exists regarding the potential rate of increase in this population. Consequently, for the purposes of this assessment, the maximum net productivity rate was assumed to be 0.04, consistent with values used for other cetaceans for which direct observations of maximum rate of increase are not available, and following a recommendation from the Atlantic Scientific Review Group. The 0.04 value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is **74,695 (CV=0.22)** ~~48,289 (CV=0.14)~~. The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the Gulf of Maine/Bay of Fundy harbor porpoise is **747** ~~483~~.

ANNUAL HUMAN-CAUSED MORTALITY

Data to estimate the mortality and serious injury of harbor porpoise come from USA and Canadian Sea Sampling Programs and from records of strandings in USA waters. Estimates using Sea Sampling Program data are discussed by fishery under the Fishery Information section below (Table 2). Strandings records are discussed under the unknown gill net fishery in the Fishery Information section (Table 3) and under the Other Mortality section (Tables 4 to 5).

A take reduction plan was implemented 01 January 1999 to reduce takes of harbor porpoises in USA Atlantic gillnet fisheries. Because this plan changed the USA gillnet fisheries, only 1999 USA mortality estimates are representative of the current USA mortality. The total annual estimated average human-caused mortality is 382 harbor porpoises per year. This is derived from four components: 323 harbor porpoise per year (CV=0.25) from USA fisheries using observer data, 39 per year (unknown CV) from Canadian fisheries using observer data, 19 per year from USA unknown fisheries using strandings data, and 1 per year from unknown human-caused mortality (a mutilated stranded harbor porpoise).

Fishery Information

Recently, Gulf of Maine/Bay of Fundy harbor porpoise takes have been documented in the USA Northeast multispecies sink gillnet, mid-Atlantic coastal gillnet, Atlantic pelagic drift gillnet fisheries, and in the Canadian Bay of Fundy groundfish sink gillnet and herring weir fisheries. The USA average annual mortality estimate for 1994 to 1998 from the above USA fisheries was 1,521 (CV=0.10) harbor porpoises (Table 2). The Canadian average annual mortality estimate for 1994 to 1998 from the above Canadian fisheries is 57 harbor porpoises. It was not possible to estimate variance of the Canadian estimate. The total average annual mortality estimate for 1994 to 1998 from the USA and Canadian fisheries is 1,578 (Table 2).

EARLIER INTERACTIONS

Pelagic Drift Gillnet

In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. The fishery operated during 1998. Then, in January 1999 NMFS issued a Final Rule to prohibit the use of drift net gear in the North Atlantic swordfish fishery (50 CFR Part 630). One harbor porpoise was observed taken from the Atlantic pelagic drift gillnet fishery during 1991-1998. The estimated total number of hauls in the Atlantic pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. In 1994 to 1998 there were 11, 12, 10, 0, and 11 vessels, respectively, in the fishery (Table 2). The estimated number of hauls in 1991, 1992, 1993, 1994, 1995 and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Observer coverage, expressed as percent of sets observed was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, 64% in 1996, and 99% in 1998. The decline in observer coverage in 1996 is attributable to trips made by vessels that were deemed unsafe for observers due to the size or condition of the fishing vessel. Fishing effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year suggested that the drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch after 1993 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in logbooks. Variances were estimated using bootstrap re-sampling techniques (Bisack 1997b). The one observed bycatch was notable because it occurred in continental shelf edge waters adjacent to Cape Hatteras (Read *et al.* 1996). Estimated annual fishery-related mortality (CV in parentheses) attributable to this fishery was 0.7 in 1989 (7.00), 1.7 in 1990 (2.65), 0.7 in 1991 (1.00), 0.4 in 1992 (1.00), 1.5 in 1993 (0.34), 0 in 1994 to 1996, and 0 in 1998. The fishery was closed during 1997. Average estimated harbor porpoise mortality and serious injury in the Atlantic pelagic drift gillnet fishery during 1994-1998 was 0.0 (Table 2).

USA

Recent data on incidental takes in USA fisheries are available from several sources. The only source that documented harbor porpoise bycatch is the Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program that was initiated in 1990, and since that year, several fisheries have been covered by the program.

Northeast Multispecies-Sink Gillnet

Before 1998, most of the harbor porpoise takes from USA fisheries were from the Northeast multispecies-sink gillnet fishery. In 1984 the Northeast multispecies-sink gillnet fishery was investigated by a sampling program that collected information concerning marine mammal bycatch. Approximately 10% of the vessels fishing in Maine, New Hampshire, and Massachusetts were sampled. Among the eleven gillnetters who received permits and logbooks, 30 harbor porpoises were reported caught. It was estimated, using rough estimates of fishing effort, that a maximum of 600 harbor porpoises were killed annually in this fishery (Gilbert and Wynne 1985, 1987).

In 1990, an observer program was started by NMFS to investigate marine mammal takes in the Northeast multispecies sink gillnet fishery. There have been 437~~423~~ harbor porpoise mortalities related to this fishery observed between 1990 and 199~~98~~ and one was released alive and uninjured. In 1993, there were approximately 349 full and part-time vessels in the Northeast multispecies-sink gillnet fishery (Table 2). An additional 187 vessels were reported to occasionally fish in the Gulf of Maine with gillnets for bait or personal use; however, these vessels were not covered by the observer program (Walden 1996) and their fishing effort was not used in estimating mortality. During 1998, it was estimated there were 301 full and part-time vessels participating in this fishery. This is the number of unique vessels in the commercial landings database (Weighout) that reported catch from this fishery during 1998 from the states of Rhode Island to Maine. This does not include a small percentage of records where the vessel number was missing. Observer coverage in terms of trips has been 1%, 6%, 7%, 5%, 7%, 5%, 4%, 6%, ~~and 5%~~, and 6% for years 1990 to 199~~98~~, respectively. Bycatch in the northern Gulf of Maine occurs primarily from June to September; while in the southern Gulf of Maine bycatch occurs from January to May and September to December. Annual estimates of harbor porpoise bycatch in the Northeast multispecies-sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Bycatch estimates included a correction factor for the under-recorded number of by-caught animals that occurred during unobserved hauls on trips with observers on the boat, when applicable. Need for such a correction became evident following re-analysis of data from the sea sampling program indicating that for some years bycatch rates from unobserved hauls were lower than that for observed hauls. Further analytical details are given in Palka (1994), CUD (1994), and Bravington and Bisack (1996). These revised bycatch estimates replace those published earlier (Smith *et al.* 1993). Estimates presented here are still negatively biased because they do not include harbor porpoises that fell out of the net while still underwater. This bias cannot be quantified at this time. Estimated annual bycatch (CV in parentheses) from this fishery during 1990-199~~98~~ was 2,900 in 1990 (0.32), 2,000 in 1991 (0.35), 1,200 in 1992 (0.21), 1,400 in 1993 (0.18) (Bravington and Bisack 1996; CUD 1994), 2100 in 1994 (0.18), 1400 in 1995 (0.27) (Bisack 1997a), 1200 (0.25) in 1996, 782 (0.22) in 1997, ~~and 332 (0.46) in 1998, and 270 (0.28) in 1999~~. The increase in the 1998 CV is mainly due to the small number of observed takes.

There appeared to be no evidence of differential mortality in USA or Canadian gillnet fisheries by age or sex in animals collected before 1994, although there was substantial inter-annual variation in the age and sex composition of the bycatch (Read and Hohn 1995). ~~Using observer data collected during 1990 to 1998 and a logit regression model, females were 11 times more likely to be caught in the offshore southern Gulf of Maine region, males were more likely to be caught in the south Cape Cod region, and the overall proportion of males and females caught in a gillnet and brought back to land were not significantly different (Lamb 2000). However, with a larger sample, from harbor porpoises examined by necropsy or from tissues received from sea sampling observers (n=171 between 1989 and 1997); the sex ratio is now 58 females and 113 males (A. Read, pers. comm.). Investigations are currently underway to determine spatial-temporal patterns in the sex ratio.~~

Two preliminary experiments, using acoustic alarms (pingers) attached to gillnets, that were conducted in the Gulf of Maine during 1992 and 1993 and took 10 and 33 harbor porpoises, respectively. During fall 1994, a controlled scientific experiment was conducted in the southern Gulf of Maine, where all nets with and without active pingers were observed (Kraus *et al.* 1997). In this experiment 25 harbor porpoises were taken in 423 strings with non-active pingers (controls) and two harbor porpoises were taken in 421 strings with active pingers. In addition, 17 other harbor porpoises were taken in nets that did not follow the experimental protocol (Table 2). From 1995 to 1997, experimental fisheries were conducted where all nets in a designated area were required to use pingers and only a sample of the nets were observed. During November-December 1995, the experimental fishery was conducted in the southern Gulf of Maine (Jeffreys Ledge) region, where no harbor porpoises were observed taken in 225 pingered nets. During 1995, all takes

from pingered nets were added directly to the estimated total bycatch for that year. During April 1996, three other experimental fisheries occurred. In the Jeffreys Ledge area, in 88 observed hauls using pingered nets nine harbor porpoises were taken. In the Massachusetts Bay region, in 171 observed hauls using pingered nets, two harbor porpoises were taken. And, in a region just south of Cape Cod, in 53 observed hauls using pingered nets no harbor porpoises were taken. During 1997, experimental fisheries were allowed in the mid-coast region during March 25 to April 25 and November 1 to December 31. During the 1997 spring experimental fishery, 180 hauls were observed with active pingers and 220 hauls were controls (silent). All observed harbor porpoise takes were in silent nets: 8 in nets with control (silent) pingers, and 3 in nets without pingers. Thus, there was a statistical difference between the catch rate in nets with pingers and silent nets (Kraus and Brault in press). During the 1997 fall experimental fishery, out of 125 observed hauls using pingered nets no harbor porpoises were taken.

From 95 stomachs of harbor porpoises collected in groundfish gillnets in the Gulf of Maine between September and December 1989-94, Atlantic herring (*Clupea harengus*) was the most important prey. Pearlsides (*Maurolicus weitzmani*), silver hake (*Merluccius bilinearis*) and red and white hake (*Urophycis* spp.) were the next most common prey species (Gannon *et al.* 1998).

Average estimated harbor porpoise mortality and serious injury in the Northeast multispecies sink gillnet fishery during 1994-1998 before the Take Reduction Plan was 1,163 (0.11). Because the Take Reduction Plan to reduce takes in USA Atlantic gillnets changed fishing practices during 1999, the current average annual harbor porpoise mortality and serious injury in the Northeast sink gillnet fishery is from 1999 only: 270 (0.28).

Mid-Atlantic Coastal Gillnet

Before an observer program was in place, Polacheck *et al.* (1995) reported one harbor porpoise incidentally taken in shad nets in the York River, Virginia. In July 1993 an observer program was initiated in the mid-Atlantic coastal gillnet fishery by the NEFSC Sea Sampling program. This fishery, which extends from North Carolina to New York, is actually a combination of small vessel fisheries that target a variety of fish species, some of the vessels operate right off the beach, some using drift nets and others using sink nets. During 1998, it was estimated that there were 302 full and part-time sink gillnet vessels and an undetermined number of drift gillnet vessels participating in this fishery. This is the number of unique vessels in the commercial landings database (Weighout) that reported catch from this fishery during 1998 from the states of Connecticut to North Carolina. This does not include a small percentage of records where the vessel number was missing. Twenty trips were observed during 1993. During 1994 and 1995, 221 and 382 trips were observed, respectively. Observer coverage, expressed as percent of tons of fish landed, was 5% for 1995, 4% for 1996, 3% for 1997, and 5% for 1998, and 6% for 1999 (Table 2). No harbor porpoises were taken in observed trips during 1993 and 1994. During 1995 to 1999, respectively, 6, 19, 32, and 53, and 3 harbor porpoises were observed taken (Table 2). Observed fishing effort has been concentrated off New Jersey and scattered between New York, Delaware and North Carolina from the beach to 50 miles off the beach. Documented bycatches after during 1995 to 1998 were from December to May. Bycatch estimates were calculated using methods similar to that used for bycatch estimates in the Northeast multispecies gillnet fishery (Bravington and Bisack 1996; Bisack 1997a). After During 1998, a separate bycatch estimate was made for the drift gillnet and set gillnet sub-fisheries. The number presented here is the sum of these two sub-fisheries. The estimated annual mortality (CV in parentheses) attributed to this fishery was 103 (0.57) for 1995, 311 (0.31) for 1996, 572 (0.35) for 1997, and 446 (0.36) for 1998, and 53 (0.49) for 1999. Annual average estimated harbor porpoise mortality and serious injury from the mid-Atlantic coastal gillnet fishery before the Take Reduction Plan (during 1995 to 1998) was 358 (CV=0.20) (Table 2). Because the Take Reduction Plan to reduce takes in USA Atlantic gillnets changed fishing practices during 1999, the current average annual harbor porpoise mortality and serious injury in the Mid-Atlantic coastal gillnet fishery is from 1999 only, 53 (0.49).

Unknown Fishery

The strandings and entanglement database, maintained by the New England Aquarium and the Northeast Regional Office/NMFS, reported 228 stranded harbor porpoises during 1999 (see Other Mortality section for more details). Of these 228, it was determined that the cause of death of 19 stranded harbor porpoises was due to gillnets and these animals were in areas and times that were not included in the above mortality estimate derived from observer program data (Table 3).

Pelagic Drift Gillnet

Because no harbor porpoises were taken in this fishery during the most recent five year period, 1994 to 1998, this section will be removed during the next update. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. The fishery operated during 1998. Then, in January 1999 NMFS issued

a Final Rule to prohibit the use of drift net gear in the North Atlantic swordfish fishery (50 CFR Part 630). One harbor porpoise was observed taken from the Atlantic pelagic drift gillnet fishery during 1991-1998. The estimated total number of hauls in the Atlantic pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. In 1994 to 1998 there were 11, 12, 10, 0, and 11 vessels, respectively, in the fishery (Table 2). The estimated number of hauls in 1991, 1992, 1993, 1994, 1995 and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Observer coverage, expressed as percent of sets observed was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, 64% in 1996, and 99% in 1998. The decline in observer coverage in 1996 is attributable to trips made by vessels that were deemed unsafe for observers due to the size or condition of the fishing vessel. Fishing effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year suggested that the drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch after 1993 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in logbooks. Variances were estimated using bootstrap re-sampling techniques (Bisack 1997b). The one observed bycatch was notable because it occurred in continental shelf edge waters adjacent to Cape Hatteras (Read *et al.* 1996). Estimated annual fishery-related mortality (CV in parentheses) attributable to this fishery was 0.7 in 1989 (7.00), 1.7 in 1990 (2.65), 0.7 in 1991 (1.00), 0.4 in 1992 (1.00), 1.5 in 1993 (0.34), 0 in 1994 to 1996, and 0 in 1998. The fishery was closed during 1997. Average estimated harbor porpoise mortality and serious injury in the Atlantic pelagic drift gillnet fishery during 1994-1998 was 0.0 (Table 2).

North Atlantic Bottom Trawl

One harbor porpoise mortality was observed in the North Atlantic bottom trawl fishery between 1989 and 1998. Vessels in this fishery, a Category III fishery under the MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. An average of 970 (CV=0.04) vessels (full and part time) participated annually in the fishery during 1989-1993. This fishery is active in New England waters in all seasons. The one take occurred in February 1992 east of Barnegatt Inlet, New York at the continental shelf break. The animal was clearly dead prior to being taken by the trawl, because it was severely decomposed and the tow duration of 3.3 hours was insufficient to allow extensive decomposition; therefore, the estimated bycatch for this fishery is 0.

CANADA

Hooker *et al.* (1997) summarized bycatch data from a Canadian fisheries observer program that placed observers on all foreign fishing vessels operating in Canadian waters, on between 25-40% of large Canadian fishing vessels (greater than 100 feet long), and on approximately 5% of smaller Canadian fishing vessels. No harbor porpoises were observed taken.

Bay of Fundy Sink Gillnet

During the early 1980's, Canadian harbor porpoise bycatch in the Bay of Fundy sink gillnet fishery, based on casual observations and discussions with fishermen, was thought to be low. The estimated harbor porpoise bycatch in 1986 was 94-116 and in 1989 it was 130 (Trippel *et al.* 1996). The Canadian gillnet fishery occurs mostly in the western portion of the Bay of Fundy during the summer and early autumn months, when the density of harbor porpoises is highest. Polacheck (1989) reported there were 19 gillnetters active in 1986, 28 active in 1987, and 21 in 1988.

More recently, an observer program implemented in the summer of 1993 provided a total bycatch estimate of 424 harbor porpoises (± 1 SE: 200-648) from 62 observed trips, (approximately 11.3% coverage of the Bay of Fundy trips) (Trippel *et al.* 1996).

During 1994, the observer program was expanded to cover 49% of the gillnet trips (171 observed trips). The bycatch was estimated to be 101 harbor porpoises (95% confidence limit: 80-122), and the fishing fleet consisted of 28 vessels (Trippel *et al.* 1996).

During 1995, due to groundfish quotas being exceeded, the gillnet fishery was closed from July 21 to August 31, 1995. During the open fishing period of 1995, 89% of the trips were observed, all in the Swallowtail region. Approximately 30% of these observed trips used pingered nets. The estimated bycatch was 87 harbor porpoises (Trippel *et al.* 1996). No confidence interval was computed due to lack of coverage in the Wolves fishing grounds.

During 1996, the Canadian gillnet fishery was closed during July 20-31 and August 16-31 due to reduced groundfish quotas. From the 107 monitored trips, the bycatch in 1996 was estimated to be 20 harbor porpoises (Trippel *et al.* 1999; DFO 1998). Trippel *et al.* (1999) estimated that during 1996, gill nets equipped with acoustic alarms reduced harbor porpoise bycatch rates by 68% over nets without alarms in the Swallowtail area of the lower Bay of Fundy.

During 1997, the fishery was closed to the majority of the gillnet fleet during July 18-31 and August 16-31, due to reduced groundfish quotas. In addition a time-area closure to reduce porpoise bycatch in the Swallowtail area occurred during September 1-7, 1997. From the 75 monitored trips during 1997, 19 harbor porpoises were observed taken. After accounting for total fishing effort, the estimated bycatch in 1997 was 43 animals (DFO 1998). Trippel *et al.* (1999) estimated that during 1997, gill nets equipped with acoustic alarms reduced harbor porpoise bycatch rates by 85% over nets without alarms in the Swallowtail area of the lower Bay of Fundy.

During 1998, the number of fishing vessels was appreciably lower than in previous years due to very poor groundfish catch rates, even though the fishery was open July to September. Seventeen trips were monitored and one harbor porpoise mortality was observed. Fishers independently reported an additional four porpoises. The Wolves and Head Harbour area had seven fishing trips in July and did not receive observer coverage. A preliminary total bycatch for Bay of Fundy in 1998 was estimated at 10 porpoises. Estimates of variance are not available (DFO 1998).

During 1999, observer coverage was from July to early September. Three fishing vessels were observed, one each near the Wolves, Digby Neck, and McDormand Patch, for a total of 179 observed hauls. Three harbor porpoise takes were observed. Preliminary analyses indicate the total mortality estimate is not likely to exceed 20 harbor porpoises (Trippel, pers. comm.). Acoustic reflective nets were also tested during this fishing season.

Average estimated harbor porpoise mortality in the Canadian groundfish sink gillnet fishery during 1995-1998 was 3652 (Table 2). An estimate of variance is not possible.

Herring Weirs

Harbor porpoises are taken frequently in Canadian herring weirs, but there have been no recent efforts to observe takes in the USA component of this fishery. Harbor porpoises takes have been observed frequently in Canadian herring weirs, though not recently in USA herring weirs. However, no program has been set up to observe USA fishing weirs. In the Bay of Fundy, weirs are operating from May to September each year. Weirs are found along the southwestern shore of the Bay of Fundy, and scattered along the coasts of western Nova Scotia and northern Maine coasts. In 1990, there were 180 active weirs in the western Bay of Fundy and 56 active weirs in Maine in 1990 (Read 1994). According to state of Maine officials, in 1998, the number of weirs in Maine waters has dropped to nearly zero due to the limited herring market (Jean Chenoweth, pers. comm.), and in 2000, only 11 weirs were built (Molyneux 2000). According to Canadian DFO officials, for 1998, there were 225 licenses for herring weirs on the New Brunswick side and 30 from the Nova Scotia side of the Bay of Fundy (in New Brunswick: 60 from Grand Manan Island, 95 from Deer and Campobello Islands, 30 from Passamaquoddy Bay, 35 from East Charlotte area, and 5 from the Saint John area). The number of licenses has been fairly consistent since 1985 (Ed Trippel, pers. comm.), but the number of active weirs is less than the number of licenses, and has been decreasing every year, primarily due to competition with salmon mariculture sites (A. Read, pers. comm.).

Smith *et al.* (1983) estimated that, in 1980, approximately 70 harbor porpoises become trapped annually and, on average, 27 died annually, and the rest were released alive. In 1990, at least 43 harbor porpoises were trapped in Bay of Fundy weirs in 1990, but the number killed was unknown (Read 1994). In 1993, after a cooperative program between fishermen and Canadian biologists was initiated began, over 100 harbor porpoises were released alive and an unknown number died (Read 1994). Between 1992 and 1994, this cooperative program resulted in the live release of 206 of Due to the cooperative program, out of 263 documented harbor porpoises caught in herring weirs during 1992 to 1994, 57 died while the rest were either released or escaped. The numbers that died during the seining process (and were released alive) were Mortalities (and releases) were 11 (and 50) in 1992, 33 (and 113) in 1993, and 13 (and 43) in 1994 (Neimanis *et al.* 1995). Since that time, an additional a further 217 harbor porpoises have been documented in Canadian herring weirs, of which 203 were released or escaped and 14 died. Out of 125 documented harbor porpoises caught in herring weirs during 1995 to 1998, 11 died while the rest were either released or escaped. The numbers that died (and were released alive or escaped) Mortalities (and releases) were 5 (and 60) in 1995; 2 (and 4) in 1996; 2 (and 24) in 1997; and 2 (and 26) in 1998; and 3 (and 89) in 1999 (A. Read Westgate, pers. comm.).

Clinical hematology values were obtained from 29 harbor porpoises released from Bay of Fundy herring weirs (Koopman *et al.* 1999). indicated that values were different than that reported in the literature for captive porpoises

(Koopman *et al.* 1999). These data represent a baseline for free-ranging harbor porpoises that can be used as a reference for long-term monitoring of the health of this population, a mandate by the MMPA.

Average estimated harbor porpoise mortality in the Canadian herring weir fishery during 1995-1998 was 2.84 (Table 2). An estimate of variance is not possible.

Table 2. **From observer program data, s**Summary of the incidental mortality of harbor porpoise (*Phocoena phocoena*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type ¹	Observer Coverage ²	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
USA								
Northeast Multispecies Sink Gillnet	Before TRP ⁷ 94-98	1993=349 1998=301	Obs. Data Weighout, Trip Logbook	.07, .05, .04, .06, .05	99 ³ , 43 ³ , 52 ³ , 47 ³ , 12 ³	2100 ³ , 1400 ³ , 1200 ³ , 782 ³ , 332 ³	.18, .27, .25, .22, .46	1163 (.11)
Northeast Sink Gillnet	After TRP ⁷ 99	1998=301	Obs. Data, Weighout, Trip Logbook	.06	14 ³	270 ³	.28	270 (.28)
Mid-Atlantic Coastal-Sink Gillnet	Before TRP ⁷ 95-98 ⁴	1998=302 ⁹	Obs. Data Weighout	.05, .04, .03, .05	6, 19, 32, 53	103, 311, 572, 446	.57, .31, .35, .36	358 (0.20)
Mid-Atlantic Coastal Gillnet	After TRP ⁷ 99	1998=302 ⁹	Obs. Data Weighout	.06	3	53	.49	53 (.49)
Pelagic Drift Gillnet	94-98	1994=11 1995=12 1996=10 1997=NA ⁵ 1998=13	Obs. Data Logbook	.87, .99, .64, NA ⁵ , .99	0, 0, 0, NA ⁵ , 0	0, 0, 0, NA ⁵ , 0	0, 0, 0, NA ⁵ , 0	0.0 ⁵ (0)
USA TOTAL								323 (0.25) 1521 (0.10)
CANADA								
Groundfish Sink Gillnet	94-98 95-99	1994=28	Obs. Data Can. Trips	.49, .89, .8, .8, .8, NA ⁸	49, 25, 13, 19, 1, 3	101, 87, 20, 43, 10, 20 ⁸	NA	36 52 (NA)
Herring Weir	94-98 95-99	1998=255 licenses ⁶	Coop. Data	NA	13, 5, 2, 2, 2, 3	13, 5, 2, 2, 2, 3	NA	2.8 4.8 (NA)
CANADIAN TOTAL								39 57 (NA)

Fishery	Years	Vessels	Data Type ¹	Observer Coverage ²	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
TOTAL								362 1578 (NA)

NA = Not available.

¹ Observer data (Obs. Data) are used to measure bycatch rates; the USA data are collected by the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program, the Canadian data are collected by DFO. NEFSC collects Weighout (Weighout) landings data, that are used as a measure of total effort for the USA ~~sink~~-gillnet fisheries. The Canadian DFO catch and effort statistical system collected the total number of trips fished by the Canadians (Can. trips), which was the measure of total effort for the Canadian groundfish gillnet fishery. Mandatory trip logbook (Trip Logbook) data are used to determine the spatial distribution of ~~some~~ fishing effort in the Northeast ~~multispecies~~-sink gillnet fishery. ~~Mandatory logbook (Logbook) data, used to measure total effort for the pelagic drift gillnet fishery, are collected at the Southeast Fisheries Science Center (SEFSC).~~ Observed mortalities from herring weirs are collected by a cooperative program between fishermen and Canadian biologists (Coop. Data).

² The observer coverage for the USA and Canadian sink gillnet fishery is measured in trips, ~~for the pelagic drift gillnet fishery the unit of effort is a set~~, and for the mid-Atlantic coastal ~~sink~~-gillnet fishery the unit of effort is tons of fish landed.

³ Harbor porpoise taken before 1997 in observed pinger trips were added directly to the estimated total bycatch for that year. During 1997, harbor porpoises were taken on non-pingered scientific experimental strings within a time/area stratum that required pingers; ~~and~~ during 1998, harbor porpoises were taken on a pingered string within a stratum that did not require pingers; ~~and~~ during 1999, harbor porpoises were taken on pingered strings within strata that required pingers but that stratum also had observed strings without pingers. For 1998 and 1999 estimates, ~~in both cases~~, a weighted bycatch rate was applied to effort from both pingered and non-pingered hauls within ~~the above~~ that stratum. The weighted bycatch rate was:

$$\sum_i^{\text{ping, non-ping}} \frac{\# \text{porpoise}_i}{\text{sslandings}_i} \cdot \frac{\# \text{hauls}_i}{\text{total\#hauls}}$$

There were 10, 33, 44, 0, 11, 0, ~~and 2~~, and 8 observed harbor porpoise takes on pinger trips from 1992 to 1999, respectively, that are included in the observed mortality column. In addition, there were 9, 0, 2, ~~and 1~~, and 1 observed harbor porpoise takes in 1995, ~~1997, and 1998~~ to 1999, respectively, on trips dedicated to fish sampling versus dedicated to watching for marine mammals; these are included in the observed mortality column (Bisack 1997a).

⁴ Only data after 1994 are reported because the observed coverages during 1993 and 1994 were negligible during the times of the year when harbor porpoise takes were possible.

~~⁵ Fishery closed during 1997. So average bycatch is from 1994, 1995, 1996 and 1998.~~

⁶ There were 255 licenses for herring weirs in the Canadian Bay of Fundy region.

⁷ Effective 01 January 1999, a take reduction plan (TRP) was put into place to reduce bycatch of harbor porpoises in gillnets. See the section "USA Management Measures Taken to Reduce Bycatch" for more details.

⁸ 1999 Canadian gillnet bycatch estimates are not completed. In total, 179 strings (60 trips) were observed. Preliminary analyses indicate bycatch is likely not to exceed 20 animals. (Trippel, pers. comm.)

⁹ Sink gillnet vessels only. Number of drift gillnet vessels presently undetermined.

Table 3. From strandings and entanglement data, summary of confirmed incidental mortality of harbor porpoises (*Phocoena phocoena*) by fishery: includes years sampled (Years), number of vessels active within the fishery (Vessels), type of data used (Data Type), mortalities assigned to this fishery (Mortality), and mean annual mortality.

Fishery	Years	Vessels	Data Type ¹	Observed Mortality	Mean Annual Mortality
Unknown gillnet fishery	99	NA	Entanglement & Strandings	19	19
TOTAL					19

NA=Not Available.

¹ Data from records in the entanglement and strandings data base maintained by the New England Aquarium and the Northeast Regional Office/NMFS (Entanglement and Strandings).

Other Mortality

USA

There is evidence that harbor porpoises were harvested by natives in Maine and Canada before the 1960's, and the meat was used for human consumption, oil, and fish bait (NEFSC 1992). The extent of these past harvests is unknown, though it is believed to have been small. Up until the early 1980's, small kills by native hunters (Passamaquoddy Indians) were reported. In recent years it was believed to have nearly stopped (Polacheck 1989) until recent public media reports in September 1997 depicted a Passamaquoddy tribe member dressing out a harbor porpoise. Further articles describing use of porpoise products for food and other purposes were timed to coincide with ongoing legal action in state court.

During 1993, seventy-three harbor porpoises were reported stranded on beaches from Maine to North Carolina (Table 43; Smithsonian Marine Mammal Database). Sixty-three of those harbor porpoises were reported stranded in the USA mid-Atlantic region from New York to North Carolina between February and May. Many of the mid-Atlantic carcasses recovered in this area during this time period had cuts and body damage suggestive of net marking (Haley and Read 1993). Five out of eight carcasses and fifteen heads from the strandings that were examined showed signs of human interactions (net markings on skin and missing flippers or flukes). Decomposition of the remaining animals prevented determination of the cause of death. Earlier reports of harbor porpoise entangled in gillnets in Chesapeake Bay and along the New Jersey coast and reports of apparent mutilation of harbor porpoise carcasses, raised concern that the 1993 strandings were related to a coastal net fishery, such as the American shad coastal gillnet fishery (Haley and Read 1993). Between 1994 and 1996, one hundred and seven harbor porpoise carcasses were recovered from beaches in Maryland, Virginia, and North Carolina and investigated by scientists. Only juvenile harbor porpoises were present in this sample. Of the 40 harbor porpoises for which cause of death could be established, twenty-five displayed definitive evidence of entanglement in fishing gear. In four cases it was possible to determine that the animal was entangled in monofilament nets (Cox *et al.* 1998).

Records of harbor porpoise strandings prior to 1997 are stored in the Smithsonian's Marine Mammal Database and records from 1997 to present are stored in the NE Regional Office/NMFS strandings and entanglement database. According to these records, the number of harbor porpoises that stranded on beaches from North Carolina to Maine during 1994 to 1999 were 106, 86, 85, 94, 118, 109, and 59, respectively (Table 43). Of these, three stranded alive on a Massachusetts beach in 1996, were tagged, and subsequently released. In 1998, two porpoises that stranded on a New Jersey beach had tags on them indicating they were originally taken on an observed mid-Atlantic coastal gill net vessel. During 1999, six animals stranded alive and were either tagged and released or brought to Mystic Aquarium for rehabilitation (Table 4). During 1999, over half of the strandings occurred on beaches of Massachusetts and North Carolina. The largest annual number of recorded strandings were from Massachusetts beaches. The states with the next largest numbers were Virginia, New Jersey, and Maryland North Carolina, in that order. The percent of these strandings that show signs of human interactions is presently being determined. The cause of death was investigated for all the 1999 strandings (Table 5). Of these, it was possible to determine the cause of death of 36 animals was due to gillnet fishery interactions. Of these 36, 19 animals were in an area and time that was not part of a bycatch estimate derived using

observer data. Thus, these 19 mortalities are attributed to an unknown gillnet fishery (Table 3). One additional animal was mutilated (right flipper and fluke was cut off). This animal is attributed to an unknown human-caused mortality.

Stranding data probably underestimate the extent of fishery-related mortality and serious injury because not all of the marine mammals which die or are seriously injured may wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery-interaction. Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of fishery interaction.

Table 4. Summary of number of stranded harbor porpoises during January 1, 1994 to December 31, 1999⁸, by state and year.

State	Year						Total
	1994	1995	1996	1997	1998	1999	
Maine	0	0	5	6	5	3	19 16
New Hampshire	0	0	2	0	0	0	2
Massachusetts ^{1,3}	9	26	31	28 20	18 17	60	172 103
Rhode Island	3	0	1	1	0	3	8 5
Connecticut	0	0	1	0	0	0	1
New York ⁴	7	6	3	10	5	10	41 31
New Jersey ²	17	18	12	21	16	23	107 84
Delaware	3	5 4	4	4 3	7	9	32 21
Maryland	10	4	3	10	1	21	49 28
Virginia	42	18	20	12	3	40	135 95
North Carolina	15	9	12	26	4	59	125 66
TOTAL	106	86 85	94	118 109	59 58	228	691 452

¹ During 1996 three animals stranded alive on a Massachusetts beach. They were tagged and released.

² Two of the porpoises that stranded on a New Jersey beach in 1998 had been previously tagged and released from an observed mid-Atlantic coastal gill net fishing vessel.

³ Five animals stranded alive in 1999 and were tagged and released.

⁴ One animal stranded alive in 1999, rehabilitated at Mystic Aquarium and died at the aquarium in April 2000.

Table 5. Cause of mortality of USA stranded harbor porpoises during January 1, 1999 to December 31, 1999. “Unique FI” is a fishery interaction that is in a time and area that could not be part of the mortality estimate derived from the observer program. “Not unique FI” is a fishery interaction that was in a time and area that may be part of the observer program derived mortality estimate. “No FI” is the cause of death was determined not to be related to a fishery interaction. “Alive” is stranded animal not dead. “CBD/Unk” is could not be determined or unknown cause of death.

Year	Unique FI ¹	Mutilation ²	Not unique FI	No FI	Emaciated	CBD/Unk	Alive	Total
1999	19	1	19	41	30	112	6	228

¹ Attributed to an unknown gillnet fishery.

² Attributed to an unknown human-caused mortality.

CANADA

Whales and dolphins stranded between 1991 and 1996 on the coast of Nova Scotia were documented by the Nova Scotia Stranding Network (Hooker *et al.* 1997). Strandings on the beaches of Sable Island during 1970 to 1998 were documented by researchers with Fisheries and Oceans, Canada (Lucas and Hooker 2000+1997). Sable Island is approximately 170 km southeast of mainland Nova Scotia. On the mainland of Nova Scotia, a total of eight stranded harbor porpoises were recorded between 1991 and 1996 (Table 64); of these, two were released alive. On Sable Island, eight two stranded dead harbor porpoises were documented, most in January and February both in January (Table 64). Two strandings during May-June 1997 were neonates (> 80 cm). The harbor porpoises that stranded in the winter (January-February) were on Sable Island, those in the spring (March to June-May) were in the Bay of Fundy (2 in Minas Basin and 1 near Yarmouth) and on Sable Island (2), and those in the summer (July to September) were scattered along the coast from the Bay of Fundy to Halifax.

Table 64. Documented number of stranded harbor porpoises, by month and year, along the coast of Nova Scotia (Hooker *et al.* 1997), and on Sable Island (Lucas and Hooker 2000+1996).

Year	Month	Number of strandings	
		Nova Scotia	Sable Island
1991	May	1	10
1992	Jan	0	1
1993	Jan	0	1
	July	1	0
	Sep	1	0
1994	Aug	1*	0
1995	Aug	1	0
1996	Mar	1	0
	Apr	1	0
	Jul	1*	0
1997	Feb	NA	3
	May	NA	1

Year	Month	Number of strandings	
		Nova Scotia	Sable Island
	June	NA	1
TOTAL		8	82

* Released alive.

NA : not available.

USA Management Measures Taken to Reduce Bycatch

A ruling to reduce harbor porpoise bycatch in USA Atlantic gill nets was published in the Federal Register (63 FR 66464) on 01 December 1998 and became effective 01 January 1999. The Gulf of Maine portion of the plan pertains to all fishing with sink gillnets and other gillnets capable of catching multispecies in New England waters, from Maine through Rhode Island. This portion of the rule includes time and area closures, some of which are complete closures; others are closed to multispecies gillnet fishing unless pingers are used in the prescribed manner. Also the rule requires those who intend to fish using pingers must attend training and certification sessions on the use of the technology. The mid-Atlantic portion of the plan pertains to waters west of 72° 30' W longitude to the mid-Atlantic shore line from New York to North Carolina. This portion of the rule includes time and area closures, some of which are complete closures; others are closed to gillnet fishing unless the gear meets certain specifications.

STATUS OF STOCK

The status of harbor porpoises, relative to OSP, in the USA Atlantic EEZ is unknown. On January 7, 1993, the National Marine Fisheries Service (NMFS) proposed listing the Gulf of Maine harbor porpoise as threatened under the Endangered Species Act (NMFS 1993). On January 5, 1999, NMFS determined the proposed listing was not warranted (NMFS 1999). On or before July 31, 2001, NMFS will make available a review of the biological status of the Gulf of Maine/Bay of Fundy harbor porpoise population. There are insufficient data to determine population trends for this species. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because average annual fishery-related mortality and serious injury exceeded PBR for many years before the 1999 Take Reduction Plan and the take after the Plan has been below PBR for only one year.

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HARBOR SEAL (*Phoca vitulina*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The harbor seal is found in all nearshore waters of the Atlantic Ocean and adjoining seas above about 30 degrees latitude (Katona *et al.* 1993). In the western North Atlantic, they are distributed from the eastern Canadian Arctic and Greenland south to southern New England and New York, and occasionally to the Carolinas (Boulva and McLaren 1979; Katona *et al.* 1993; Gilbert and Guldager 1998). Although the stock structure of the western North Atlantic population is unknown, it is thought that harbor seals found along the eastern USA and Canadian coasts represent one population (Temte *et al.* 1991). Breeding and pupping normally occur in waters north of the New Hampshire/Maine border, although breeding occurred as far south as Cape Cod in the early part of the twentieth century (Temte *et al.* 1991; Katona *et al.* 1993).

Harbor seals are year-round inhabitants of the coastal waters of eastern Canada and Maine (Katona *et al.* 1993), and occur seasonally along the southern New England and New York coasts from September through late May (Schneider and Payne 1983). In recent years, their seasonal interval along the southern New England to New Jersey coasts has increased (Barlas 1999; Hoover *et al.* 1999; Slocum *et al.* 1999). (Scattered sightings and strandings have been recorded as far south as Florida (NMFS unpublished data). A general southward movement from the Bay of Fundy to southern New England waters occurs in autumn and early winter (Rosenfeld *et al.* 1988; Whitman and Payne 1990; Barlas 1999). A northward movement from southern New England to Maine and eastern Canada occurs prior to the pupping season, which takes place from mid-May through June along the Maine Coast (Richardson 1976; Wilson 1978; Whitman and Payne 1990; Kenney 1994). No pupping areas have been identified in southern New England (Payne and Schneider 1984; Barlas 1999). The overall geographic range throughout coastal New England has not changed significantly during the last century (Payne and Selzer 1989).

The majority of animals seals moving into southern New England and mid-Atlantic waters are subadults and juveniles (Whitman and Payne 1990; Katona *et al.* 1993; Slocum *et al.* 1999). Whitman and Payne (1990) suggest that the age-related dispersal may reflect the higher energy requirements of younger animals.

POPULATION SIZE

Since passage of the MMPA in 1972, the number of seals along the New England coast has increased nearly five-fold. Coast-wide aerial surveys along the Maine coast have been conducted in May/June during pupping in 1981, 1982, 1986, 1993, and 1997 (Table 1; Gilbert and Stein 1981; Gilbert and Wynne 1983, 1984; Kenney 1994; and Gilbert and Guldager 1998). These numbers are considered to be a minimum abundance estimate because they are uncorrected for animals in the water or outside the survey area. Increased abundance of seals in the northeast region has also been documented during aerial and boat surveys of overwintering haul-out sites in between the Maine/New Hampshire border to eastern Long Island, and New Jersey (Payne and Selzer 1989; Rough 1995; Barlas 1999; Kerri *et al.* 1999; Slocum *et al.* 1999). (Table 1). Canadian scientists counted 3,600 harbor seals during an August 1992 aerial survey in the Bay of Fundy (Stobo and Fowler 1994) (Table 1), but noted that the survey was not designed to obtain a population estimate.

Table 1. Summary of abundance estimates for the western Atlantic harbor seal. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{min}) and coefficient of variation (CV).

Month/Year	Area	N_{min}	CV
May/June 1993	Maine coast	28,810 (4,250)	None reported
May/June 1997	Maine coast	30,990 (5,359)	None reported
August 1992	Bay of Fundy	3,600	None reported
Spring 1999	Southern New England	6,083	None reported

¹Pup counts are in brackets

Minimum Population Estimate

A minimum population estimate is 30,990 seals, based on uncorrected total counts along the Maine coast in 1997.

Current Population Trend

The annual increase since 1993 has been 1.8 % (Gilbert and Guldager 1998). Since 1981, the average increase has been 4.2 % (Gilbert and Guldager 1998), about 50% of the 8.9 percent annual increase estimated by Kenney (1994) from counts through 1993. Similarly, the number of pups along the Maine coast has increased at an annual rate of 12.9% over the 1981-1997 period (Gilbert and Guldager 1998). ~~Further, the best estimate of harbor seals in southern New England is 6,083 (Table 1) is 23% greater than the peak count (4,915) reported by Payne and Selzer (1989).~~ Possible factors contributing to harbor seal population increase include MMPA protection and increased prey. ~~There are no indications that population growth has slowed or that it is at or near its potential maximum level. The rapid increase observed during the past two decades may reflect past reduction of the population by historical bounty hunting, possibly to a very low level.~~

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.12. This value is based on theoretical modeling showing that pinniped populations may not grow at rates much greater than 12% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 30,990. The maximum productivity rate is 0.12, the default value for pinnipeds. The recovery factor (F_R) for this stock is 1.0, the value for stocks of unknown status, but known to be increasing. PBR for USA waters is 1,859.

ANNUAL HUMAN-CAUSED MORTALITY

Total annual estimated average fishery-related mortality or serious injury to this stock during ~~1994-1998~~ **1995-1999** was ~~873~~**895** harbor seals (CV=~~0.12~~**0.14**; Table 2).

Researchers and fishery observers have documented incidental mortality in several fisheries, particularly within the Gulf of Maine (see below). An unknown level of mortality also occurred in the mariculture industry (*i.e.*, salmon farming), and by deliberate shooting (NMFS unpublished data). ~~However, there are no recent data to indicate that shooting around aquaculture sites still takes place.~~

Fishery Information

USA

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

Incidental takes of harbor seals have been recorded in groundfish gillnet, herring purse seine, halibut tub trawl, and lobster fisheries (Gilbert and Wynne, 1985 and 1987). A study conducted by the University of Maine reported a combined average of 22 seals entangled annually by 17 groundfish gillnetters off the coast of Maine (Gilbert and Wynne 1987). All seals were young of the year and were caught from late June through August, and in early October. Interviews with a limited number of mackerel gillnetters indicated only one harbor seal entanglement and a negligible loss of fish to seals. Net damage and fish robbing were not reported to be a major economic concern to gillnetters interviewed (Gilbert and Wynne 1987).

Herring purse seiners have reported accidentally entrapping seals off the mid-coast of Maine, but indicated that the seals were rarely drowned before the seine was emptied (Gilbert and Wynne 1985). Capture of seals by halibut tub trawls are rare. One vessel captain indicated that he took one or two seals a year. These seals were all hooked through the skin and released alive, indicating they were snagged as they followed baited hooks. Infrequent reports suggest seals may rob bait off longlines, although this loss is considered negligible (Gilbert and Wynne 1985).

Incidental takes in lobster traps in inshore waters off Maine are reportedly rare. Captures of approximately two seal pups per port per year were recorded by mid-coastal lobstermen off Maine (Gilbert and Wynne 1985). Seals have been reported to rob bait from inshore lobster traps, especially in the spring, when fresh bait is used. These incidents may involve only a few individual animals. Lobstermen claim that seals consume shedding lobsters.

Northeast Multispecies Sink Gillnet:

In 1993, there were approximately 349 full and part-time vessels in the Northeast multispecies sink gillnet fishery, which covered the Gulf of Maine and southern New England (Table 2). An additional 187 vessels were reported to occasionally fish in the Gulf of Maine with gillnets for bait or personal use; however, these vessels were not covered by the observer program (Walden 1996) and their fishing effort was not used in estimating mortality. In 1998, there were approximately 301 vessels in this fishery (NMFS unpublished data). Observer coverage in terms of trips has been 1%, 6%, 7%, 5%, 7%, 5%, 4%, 6%, and 5%, and 6% for 1990 to 1998 1999, respectively. The fishery has been observed in the Gulf of Maine and in Southern New England. There were 287 336 harbor seal mortalities, excluding three animals taken in the 1994 pinger experiment (NMFS unpublished data), observed in the Northeast multispecies sink gillnet fishery between 1990 and 1998 1999. Annual estimates of harbor seal bycatch in the Northeast multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery during 1990-1998 1999 were 602 in 1990 (0.68), 231 in 1991 (0.22), 373 in 1992 (0.23), 698 in 1993 (0.19), 1,330 in 1994 (0.25), 1,179 in 1995 (0.21), 911 in 1996 (0.27), 598 in 1997 (0.26), and 332 in 1998 (0.33), and 1446 in 1999 (0.34). The 1994 and 1995 bycatches, respectively, include 14 and 179 animals from the estimated number of unknown seals (based on observed mortalities of seals that could not be identified to species). The unknown seals were prorated, based on spatial/temporal patterns of bycatch of harbor seals, gray seals, harp seals, and hooded seals. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 1994-1998 1995-1999 was 870 893 harbor seals (CV=0.12 0.14). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996). The bycatch occurred in Massachusetts Bay, south of Cape Ann and west of Stellwagen Bank during January-March. Bycatch locations became more dispersed during April-June from Casco Bay to Cape Ann, along the 30 fathom contour out to Jeffreys Ledge, with one take location near Cultivator Shoal and one off southern New England near Block Island. Incidental takes occurred from Frenchman's Bay to Massachusetts Bay during July-September. In inshore waters, the takes were aggregated while offshore takes were more dispersed. Incidental takes were confined from Cape Elizabeth out to Jeffreys Ledge and south to Nantucket Sound during October-December.

Mid-Atlantic Coastal Gillnet

Observer coverage of the USA Atlantic coastal gillnet fishery was initiated by the NEFSC Sea Sampling program in July, 1993; and from July to December 1993, 20 trips were observed. During 1994 and 1995 221 and 382

trips were observed, respectively. This fishery, which extends from North Carolina to New York, is actually a combination of small vessel fisheries that target a variety of fish species, some of which operate right off the beach. The number of vessels in this fishery is unknown, because records which are held by both state and federal agencies have not been centralized and standardized. Observer coverage, expressed as percent of tons of fish landed, was 5%, 4%, and 3%, ~~and 5%, and 2%~~ for 1995, 1996, 1997, ~~and 1998, and 1999~~ (Table 2).

No harbor seals were taken in observed trips during 1993-1997, ~~and in 1999~~. Two harbor seals were observed taken in 1998 (Table 2). Observed effort was concentrated off NJ and scattered between DE and NC from 1 to 50 miles off the beach. All bycatches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 0 in 1995-1997 ~~and 1999~~ and 11 in 1998 (0.77). Average annual estimated fishery-related mortality attributable to this fishery during 1995-~~1998~~1999 was ~~32~~ harbor seals (CV=~~0.77~~0.77)

CANADA

An unknown number of harbor seals have been taken in Newfoundland and Labrador, Gulf of St. Lawrence and Bay of Fundy groundfish gillnets, Atlantic Canada and Greenland salmon gillnets, Atlantic Canada cod traps, and in Bay of Fundy herring weirs (Read 1994). Furthermore, some of these mortalities (e.g., seals trapped in herring weirs) are the result of direct shooting. ~~The Canadian government has recently implemented a pilot program that permits mariculture operators to use acoustic deterrents or shoot problem seals.~~

There were 3,121 cod traps operating in Newfoundland and Labrador during 1979, and about 7,500 in 1980 (Read 1994). This fishery was closed at the end of 1993 due to collapse of Canadian groundfish resources.

Herring weirs are also distributed throughout the Bay of Fundy; it has been reported that 180 weirs were operating in the Bay of Fundy in 1990 (Read 1994).

In 1996, observers recorded seven harbor seals (one released alive) in Spanish deep water trawl fishing on the southern edge of the Grand Bank (NAFO Areas 3) (Lens, 1997). Seal bycatches occurred year-round, but interactions were highest during April-June. Many of the seals that died during fishing activities were unidentified. The proportion of sets with mortality (all seals) was 2.7 per 1,000 hauls (0.003).

Table 2. Summary of the incidental mortality of harbor seal (*Phoca vitulina*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type ¹	Observer Coverage ²	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
New England ³ Multispecies Sink Gillnet	94-98 95-99	301	Obs. Data Weighout, Logbooks	.07, .05, .04, .06, .05, .06	86, 56, 36, 48, 15, 49	1330, 1179, 911, 598, 332, 1446	.25, .21, .27, .26, .33, .34	870- (0.12) 893 (.14)
Mid-Atlantic Coastal Sink Gillnet	95-98 99	NA Unk ⁴	Obs. Data Weighout	.05, .04, .03, .05, .02	0, 0, 0, 2, 0	0, 0, 0, 11, 0	0, 0, 0, .77, 0	3 (0.77) 2 (.77)
TOTAL								873- (0.12) 895 (.14)

¹ Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects landings data (Weighout), and total landings are used as a measure of total effort for the sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of some fishing effort in the Northeast multispecies sink gillnet fishery.

² The effort for the Northeast multispecies sink gillnet fishery is measured in trips. Observer coverage of the mid-Atlantic coastal gillnet fishery is measured in tons of fish landed.

³ In ~~1994~~, 1995, 1996, 1997, 1998 and 1999 respectively, observed mortality on “marine mammal trips” was 59, 41, 37, 14, 13 and 45 animals. Only these mortalities were used to estimate total harbor seal bycatch. See Bisack (1997) for “trip” type definitions. ~~In 1994, 3 mortalities were observed on “fish trips” and 24 on “pinger trips.”~~ In 1995, 15 mortalities were recorded on “fish trips”. In 1996 two mortalities were recorded on “pinger trips” and three on “fish trips”. In 1997, one animal was taken on a “fish trip,” and 14 harbor seals were taken on pingered trips. ~~See Bisack (1997) for “trip” type definitions.~~ In 1998 two observed animals were taken of “fish trips” and one ~~common dolphin~~ harbor seal was taken on pingered trip. In 1999 four observed animals were taken on “fish trips” and five harbor seals were taken on pingered trips.

⁴ Number of vessels is not known.

Other Mortality

Harbor seals were bounty hunted in New England waters until the ~~late~~ mid- 1960's. This hunt may have caused the demise of this stock in USA waters (Katona *et al.* 1993).

Annually, small numbers of harbor seals regularly strand throughout their migratory range. Most reported strandings, however, occur during the winter period in southern New England and mid- Atlantic regions (NMFS unpublished data). Sources of mortality include human interactions (boat strikes and fishing gear, power plant intake (12-20 per year; NMFS unpublished data), oil, shooting (around salmon aquaculture sites and fixed fishing gear), storms, abandonment by the mother, and disease (Katona *et al.* 1993; NMFS unpublished data). Interactions with Maine salmon aquaculture operations appears to be increasing, although the magnitude of interactions and seal mortalities has not been quantified (Anon 1996). In 1980, more than 350 seals were found dead in the Cape Cod area from an influenza outbreak (Geraci *et al.* 1981).

The 1992-1996, and 1999 harbor seal strandings data are currently under review. In 1995 one stranding was in South Carolina. In 1997 and 1998, 153 and 256, respectively, harbor seal stranding were reported. Strandings were reported in all states between Maine and North Carolina, and in 1997 one each was in Georgia and Florida. Maine (174/409), Massachusetts (83/409), New York (53/409) and New Jersey (25/409) accounted for most of the strandings, reflecting both long coastlines and habitat use. Forty-one of the stranded animals during this two year period showed signs of human interactions: fishery (10), vessel strike (3), power plant (16), and other (12).

Stranding data probably underestimate the extent of fishery-related mortality and serious injury because not all of the marine mammals which die or are seriously injured may wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery-interaction.

STATUS OF STOCK

The status of harbor seals, relative to OSP, in the USA Atlantic EEZ is unknown, but the population is increasing. The species is not listed as threatened or endangered under the Endangered Species Act. Gilbert and Guldager (1998) estimated a 4.4% annual rate of increase of this stock in Maine coastal waters based on 1981, 1982, 1986, 1993, 1997 surveys conducted along the Maine coast. The population is increasing despite the known fishery-related mortality. Total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be approaching zero mortality and serious injury rate. This is not a strategic stock because fishery-related mortality and serious injury does not exceed PBR.

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GRAY SEAL (*Halichoerus grypus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The gray seal is found on both sides of the North Atlantic, with three major populations: in eastern Canada; northwestern Europe and the Baltic Sea (Katona *et al.* 1993). The western North Atlantic population occurs from New England to Labrador and is centered in the Sable Island region of Nova Scotia (Katona *et al.* 1993; Davies 1957). This stock is separated by both geography and differences in the breeding season from the eastern Atlantic stock (Bonner 1981). The western North Atlantic stock is distributed and breeds principally in eastern Canadian waters (Mansfield 1966). There are two breeding concentrations in eastern Canada; one at Sable Island, and a second that breeds on the pack ice in the Gulf of St. Lawrence (Hammill *et al.* 1998). Tagging studies indicate that there is little intermixing between the two breeding groups (Zwanenberg and Bowen 1990), and for management purposes, they are treated as separate populations (Mohn and Bowen 1996). However, small numbers of animals and pupping have been observed on several isolated islands along the Maine coast and in Nantucket-Vineyard Sound, Massachusetts (Katona *et al.* 1993; Rough 1995; J. R. Gilbert, pers. comm., University of Maine, Orono, ME). In recent years, a year-round breeding population of approximately 400 animals has been documented on outer Cape Cod and Nantucket Island (Dennis Murley, pers. comm., Mass. Audubon Society, Wellfleet, MA). Gilbert (pers. comm.) has also documented a resident colony in Maine.

POPULATION SIZE

Estimates of the total western Atlantic gray seal population are not available; however, four estimates of portions of the stock are available for Sable Island, the Maine coast, and Muskeget Island (Nantucket) and Monomoy, (Cape Cod) Massachusetts (Table 1). The 1993 estimate of the Sable Island and Gulf of St. Lawrence stocks was 143,000 animals (Mohn and Bowen 1994). The population in waters off Maine has increased from about 30 in the early 1980's to between 500-1,000 animals in 1993. Recently 29-49 pups/year have been recorded **at one pupping site** in Penobscot Bay, **and in winter 2000 approximately 150 gray seals (adults and pups) were recorded at a second pupping site** (J. R. Gilbert, pers. comm.). Maximum counts of individuals at a winter breeding colony on Muskeget Island, west of Nantucket Island obtained during the spring molt did not exceed 13 in any year during the 1970s, but rose to 61 in 1984, 192 in 1988, 503 in 1992, and 1,549 in 1993. Aerial surveys in April and May of 1994 recorded a peak count of 2,010 gray seals for Muskeget Island and Monomoy combined (Rough 1995). From December 1998 to July 1999 the Northeast Fisheries Science Center conducted aerial surveys in the same region surveyed by Payne and Selzer (1989) and Rough (1995). The peak gray seal count in the region between Isle of Shoals, New Hampshire and Woods Hole, Massachusetts was 5,611 (5/21/99). No gray seals were recorded at haulout sites between Newport, Rhode Island and Montauk Pt., New York (Barlas 1999). The 1999 count is 2.8 times greater than the 1994 count. Ninety three percent of the gray seals were located at two sites in the eastern end of Nantucket Sound. Fifty-four percent of the seasonal count was on Muskeget Island and adjacent sand bars in Nantucket sound, and 39% was on Monomoy Island.

Table 1. Summary of abundance estimates for the western North Atlantic gray seal. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{min}) and coefficient of variation (CV).

Month/Year	Area	N_{min}	CV
1993	Sable Island and Gulf of St. Lawrence	143,000	none reported
1993	Maine coast	500-1000	none reported
Apr-May 1994	Muskeget Island and Monomoy, MA ¹	2,010	none reported
Spring 1999	Muskeget Island and Monomoy, MA ¹	5,611	none reported

¹ These counts represent **pertain to animals seen in USA waters, and the stock relationship to animals in Canadian waters is unknown.**

Minimum Population Estimate

At the November 1998 meeting of the Atlantic Scientific Review Group (SRG), the SRG recommended that the minimum estimate (2,010) used in previous assessments be discontinued, because it can not be determined what part of the mortality comes from the Massachusetts, Maine, and Sable Island portions of the population. Therefore, present data are insufficient to calculate the minimum population estimate for USA waters. It is estimated that there are at least 143,000 gray seals in Canada (Mohn and Bowen 1996).

Current Population Trend

Gray seal abundance is likely increasing in the USA Atlantic Exclusive Economic Zone (EEZ), but the rate of increase is unknown. The population has been increasing for several decades in Canadian waters. Pup production on Sable Island, Nova Scotia, has been about 13% per year since 1962 (Stobo and Zwanenberg 1990; Mohn and Bowen 1996); whereas, in the Gulf of St. Lawrence it is increasing at a slower rate of 7.4% (Hammill *et al.* 1998). Approximately 57% of the western North Atlantic population is from the Sable Island stock.

Winter breeding colonies in Maine and on Muskeget Island may provide some measure of gray seal population trends and expansion in distribution. Sightings in New England increased during the 1980s as the gray seal population and range expanded in eastern Canada. Five pups were born at Muskeget in 1988. The number of pups increased to 12 in 1992, 30 in 1993, and 59 in 1994 (Rough 1995). Gray seal pups were recorded on three flight days during the 1998/99 winter surveys (26 January, 9 February, and 10 March). On 9 February, 77 gray seal pups (59 on Muskeget Island and 18 on South Monomoy) were recorded (Barlas 1999). These observations continue the increasing trend in pup production reported by Rough (1995). The change in gray seal counts at Muskeget and Monomoy from 2,010 in 1994 to 5,611 in 1999 represents an annual increase rate of 20.5%, however it can not be determined what proportion of the increase represents growth and immigration.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. One study that estimated pup production on Sable Island estimated the annual production rate was 13% (Mohn and Bowen 1994).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.12. This value is based on theoretical modeling showing that pinniped populations may not grow at rates much greater than 12% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is unknown. The maximum productivity rate is 0.12, the default value for pinnipeds. The recovery factor (F_R) for this stock is 1.0, the value for stocks of unknown status, but known to be increasing. PBR for the western North Atlantic gray seals in USA waters is unknown. Applying the formula to the minimum population estimate for Canadian waters results in a “PBR” of 8,850 gray seals.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality or serious injury to this stock during ~~1994-1998~~ **1995-1999** was ~~75~~**103** gray seals (CV=~~0.28~~**0.25**; Table 2).

Fishery Information

USA

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

Northeast Multispecies Sink Gillnet:

In 1993, there were approximately 349 full and part-time vessels in the Northeast multispecies sink gillnet fishery, which covered the Gulf of Maine and southern New England (Table 2). An additional 187 vessels were reported

to occasionally fish in the Gulf of Maine with gillnets for bait or personal use; however, these vessels were not covered by the observer program (Walden 1996) and their fishing effort was not used in estimating mortality. In 1998, there were approximately 301 vessels in this fishery (NMFS unpublished data). Observer coverage in terms of trips has been 1%, 6%, 7%, 5%, 7%, 5%, 4%, 6%, and 5% for 1990 to 1998, respectively. The fishery has been observed in the Gulf of Maine and in Southern New England. There were 3540 gray seal mortalities observed in the Northeast multispecies sink gillnet fishery between 1993-1998 (Table 2). Nineteen of the observed mortalities occurred in winter (January - May), 79 in the southern Gulf of Maine, and one in the "mid-coast closed area," and two in the South Cape closure. Only one mortality was observed in northern Maine waters, which occurred in autumn (September-December) 1995. One of the 1993 observed mortalities was in May, and was from SE of Block Island.

Annual estimates of gray seal bycatch in the Northeast multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery during 1990-1996 was zero in 1990-1992, 18 in 1993 (1.00), 19 in 1994 (0.95), 117 in 1995 (0.42), 49 in 1996 (0.49), 131 in 1997 (0.50), and 61 in 1998 (0.98), and 155 in 1999 (0.51). The 1995 bycatch includes 28 animals from the estimated number of unknown seals (based on observed mortalities of seals that could not be identified to species). The unknown seals were prorated, based on spatial/temporal patterns of bycatch of harbor seals, gray seals, harp seals, and hooded seals. Further, they will likely have little impact on the estimates presented. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 1994-1998 was 75 gray seals (CV=0.28). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996).

CANADA

An unknown number of gray seals have been taken in Newfoundland and Labrador, Gulf of St. Lawrence, and Bay of Fundy groundfish gillnets, Atlantic Canada and Greenland salmon gillnets, Atlantic Canada cod traps, and in Bay of Fundy herring weirs (Read 1994). In addition to incidental catches, some mortalities (e.g., seals trapped in herring weirs) were the result of direct shooting, and there were culls of about 1,700 animals annually during the 1970's and early 1980's on Sable Island (Anon. 1986).

There were 3,121 cod traps operating in Newfoundland and Labrador during 1979, and about 7,500 in 1980 (Read 1994). This fishery was closed at the end of 1993 due to collapse of Canadian groundfish resources.

Herring weirs are also distributed throughout the Bay of Fundy; it has been reported that 180 weirs were operating in the Bay of Fundy in 1990 (Read 1994).

In 1996, observers recorded three gray seals (one released alive) in Spanish deep water trawl fishing on the southern edge of the Grand Bank (NAFO Areas 3) (Lens, 1997). Seal bycatches occurred year-round, but interactions were highest during April-June. Many of the seals that died during fishing activities were unidentified. The proportion of sets with mortality (all seals) was 2.7 per 1,000 hauls (0.003).

Table 2. Summary of the incidental mortality of gray seal (*Halichoerus grypus*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type ¹	Observer Coverage ²	Observed Mortality ³	Estimated Mortality ³	Estimated CVs	Mean Annual Mortality
Northeast Multispecies Sink Gillnet	94-98 95-99	301	Obs. Data Weighout, Logbooks	.07, .05, .04, .06, .05, .06	3, 7, 3, 16, 4, 5	49, 117, 49, 131, 61, 155	.95, .42, .49, .50, .98, .51	75 (.28) 103 (.25)
TOTAL								75 (.28) 103 (.25)

¹ Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects Weighout landings data (Weighout), and total landings are used as a measure of total effort for the sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of some fishing effort in the Northeast multispecies sink gillnet fishery.

² The observer coverage for the Northeast multispecies sink gillnet fishery is measured in trips.

³ In ~~1994~~, 1995 and 1998 respectively, observed mortality on “marine mammal trips” was ~~2~~, 6 and 3 animals. Only these mortalities were used to estimate total gray seal bycatch. See Bisack (1997) for “trip” type definitions. In ~~1994~~, 1995 and 1998 one mortality in each year was recorded on a “fish trip.” See Bisack (1997) for “trip” type definitions. In 1997 all observed takes were on marine mammal trips, including 12 taken on pingered trips. In 1998 and 1999 takes from nonpingered nets within a marine mammal time/area closure that required pingers and takes from pingered nets not within a marine mammal time/area closure that required pingers were pooled with the takes from nets with and without pingers from the same stratum. The pooled bycatch rate was weighted by the total number of samples taken from the stratum and used to estimate the mortality. In 1998 one take was observed in a net without a pinger that was within a marine mammal closure that required pingers. In 1999 two takes were observed in nets with pingers.

Other Mortality

Gray seals, like harbor seals, were hunted for bounty in New England waters until the late 1960's. This hunt may have severely depleted this stock in USA waters (Rough 1995). In addition, V. Rough (pers. comm.) has documented several animals with netting around their necks in the Cape Cod/Nantucket area. An unknown level of mortality also occurs in the mariculture industry (*i.e.*, salmon farming) and by deliberate shooting (NMFS unpublished data).

The 1992-1996 gray seal strandings data are currently under review. In 1997-1998, 103 gray seal stranding were recorded, extending from Maine (17) to Maryland (2). Most of the stranding were in Maine (17), Massachusetts (28), and New York (28). Thirteen animals showed signs of human interactions: fishery (3), power plant (2), oil spill (4), shot (1), mutilated (1), other (2). Stranding data probably underestimate the extent of fishery-related mortality and serious injury because not all of the marine mammals which die or are seriously injured wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery interaction.

STATUS OF STOCK

The status of the gray seal population, relative to OSP, in USA Atlantic EEZ waters is unknown, but the populations appear to be increasing in Canadian and USA waters. The species is not listed as threatened or endangered under the Endangered Species Act. Recent data indicate that this population is increasing. The total fishery-related

mortality and serious injury for this stock is believed to be very low relative to the population size in Canadian waters and can be considered insignificant and approaching zero mortality and serious injury rate. The level of human-caused mortality and serious injury in the USA Atlantic EEZ is unknown, but believed to be very low relative to the total stock size; therefore, this is not a strategic stock.

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HARP SEAL (*Phoca groenlandica*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The harp seal occurs throughout much of the North Atlantic and Arctic Oceans (Ronald and Healey 1981; Lavigne and Kovacs 1988); however, in recent years, numbers of sightings and strandings have been increasing off the east coast of the United States from Maine to New Jersey (Katona *et al.* 1993; Stevick and Fernald 1998; B. Rubinstein, pers. comm., New England Aquarium). These appearances usually occur in January-May, when the western North Atlantic stock of harp seals is at its most southern point of migration. The world's harp seal population is divided into three separate stocks, each identified with a specific breeding site (Bonner 1990; Lavigne and Kovacs 1988). The largest stock is located in the western North Atlantic off eastern Canada and is divided into two breeding herds which breed on the pack ice. The Front herd breeds off the coast of Newfoundland and Labrador, and the Gulf herd breeds near the Magdalen Islands in the middle of the Gulf of St. Lawrence (Sergeant 1965; Lavigne and Kovacs 1988). The second stock breeds in the White Sea off the coast of the Soviet Union, and the third stock breeds on the West Ice off of eastern Greenland (Lavigne and Kovacs 1988; Anon 1998). Harp seals are highly migratory (Sergeant 1965; Stenson and Sjure 1997). Breeding occurs at different times between mid-February and April for each stock. Adults then assemble north of their whelping patches to undergo the annual molt. The migration then continues north to Arctic summer feeding grounds. In late September, after a summer of feeding, nearly all adults and some of the immature animals migrate southward along the Labrador coast, usually reaching the entrance to the Gulf of St. Lawrence by early winter. There they split into two groups, one moving into the Gulf and the other remaining off the coast of Newfoundland. Following mating, the seals disperse to feed, and in late April they again concentrate in large numbers on the ice to molt.

The extreme southern limit of the harp seal's habitat extends into the USA Atlantic Exclusive Economic Zone (EEZ) during winter and spring. The increase in numbers and geographic distribution of harp seals in New England to mid-Atlantic waters is based primarily on strandings, and secondarily on fishery bycatch (McAlpine and Walker 1990; Rubinstein 1994).

POPULATION SIZE

The total population size of harp seals is unknown; however, three seasonal abundance estimates are available which used a variety of methods including aerial surveys and mark-recapture (Table 1). Generally, these methods include surveying the whelping concentrations and modeling pup production. Harp seal pup production in the 1950s was estimated at 645,000 (Sergeant 1975), decreasing to 225,000 by 1970 (Sergeant 1975). Estimates began to increase at that time and have continued to rise, reaching 478,000 in 1979 (Bowen and Sergeant 1983; Bowen and Sergeant 1985) and 577,900 in 1990 (Stenson *et al.* 1993), and 998,000 in 1999 (Stenson *et al.* 2000).

Roff and Bowen (1983) developed an estimation model to provide a more precise estimate of total population. This technique incorporates recent pregnancy rates and estimates of age-specific hunting mortality (CAFSAC 1992).

Shelton *et al.* (1992) applied a harp seal estimation model to the 1990 pup production and obtained an estimate of 3.1 million (range 2.7-3.5 million; Stenson 1993). Using a revised population model, 1994 pup count data, and two assumptions regarding pup mortality rates; Shelton *et al.* (1996) estimated pup production and total population size for the period 1955-1994. The 1994 total population estimates were 4.5-4.8 million harp seals (Table 1). The 1999 population estimate is 4.0 - 6.4 million harp seals (Healey and Stenson 2000) (Table 1).

Table 1. Summary of abundance estimates (pups and total) for western North Atlantic harp seals. Year and area covered during each abundance survey, and resulting abundance estimate (N_{min}) and coefficient of variation (CV).

Month/Year	Area	N_{min}	CV
1994	Eastern Atlantic Canada-Labrador	702,900 pups	0.09
1994	Eastern Atlantic Canada-Labrador	4.5-4.8 million	none reported
1999	Eastern Atlantic Canada - Labrador	998,000	$\pm 200,000$ (95% CI)
1999	Eastern Atlantic Canada - Labrador	5.2 million	$\pm 1,200,000$ (95% CI)

Minimum population estimate

Present data are insufficient to calculate the minimum population estimate for USA waters. It is estimated there are at least ~~4.8~~5.2 million harp seals in Canada (~~Shelton *et al.* 1996~~Healey and Stenson 2000).

Current population trend

The population appears to be increasing in USA waters, judging from the increased number of stranded harp seals, but the magnitude of the suspected increase is unknown. In Canada, since ~~1990 the average annual growth rate has been estimated to be about 5% (Shelton *et al.* 1996).~~1996 the population has been stable (5.2 million), due to large harvests of young animals in recent years (Healey and Stenson 2000).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. The best data are based on Canadian studies. Recent studies indicate that pup production has increased, but the rate of population increase cannot be quantified at this time (Stenson *et al.* 1996). The mean age of sexual maturity was 5.8 yrs in the mid-1950's, declining to 4.6 yrs in the early 1980's and then increasing to ~~5.4 yrs in the early 1990's~~5.6 yrs in the mid 1990s (Sjare *et al.* 1996; Sjare and Stenson 2000).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.12. This value is based on theoretical modeling showing that pinniped populations may not grow at rates much greater than 12% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is unknown. The maximum productivity rate is 0.12, the default value for pinnipeds. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) was set at 1.0 because it was believed that harp seals are within OSP. PBR for the western North Atlantic harp seal in USA waters is unknown. Applying the formula to the minimum population estimate for Canadian waters results in a "PBR" of ~~288,000~~312,000 harp seals.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality or serious injury to this stock during ~~1994-1998~~1995-1999 was ~~402~~245 harp seals CV=~~0.26~~0.20; Table 2).

Fishery Information

USA

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

Recent bycatch has been observed by NMFS Sea Samplers in the Northeast multispecies sink gillnet fisheries, but no mortalities have been documented in the mid-Atlantic coastal gillnet, Atlantic drift gillnet, pelagic pair trawl or pelagic longline fisheries.

Northeast Multispecies Sink Gillnet:

In 1993, there were approximately 349 full and part-time vessels in the Northeast multispecies sink gillnet fishery, which covered the Gulf of Maine and southern New England (Table 2). An additional 187 vessels were reported to occasionally fish in the Gulf of Maine with gillnets for bait or personal use; however, these vessels were not covered by the observer program (Walden 1996) and their fishing effort was not used in estimating mortality. In 1998, there were approximately 310 vessels in this fishery (NMFS unpublished data). Observer coverage in terms of trips has been 1%, 6%, 7%, 5%, 7%, 5%, 4%, 6%, and 5%, and 6% for 1990 to 1998-1999, respectively. The fishery has been observed in the Gulf of Maine and in Southern New England. There were 114-118 harp seal mortalities observed in the Northeast multispecies sink gillnet fishery between 1990 and 1998-1999. Annual estimates of harp seal bycatch in the Northeast multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery during 1990-1998-1999 was zero (1990-1993), 861 in 1994 (0.58), 694 in 1995 (0.27), 89 in 1996 (0.55), 269 in 1997 (0.50), and 78 in 1998 (0.48), and 81 in 1999 (0.78). The 1994 and 1995 bycatches, respectively, include 16 and 153 animals from the estimated number of unknown seals (based on observed mortalities of seals that could not be identified to species). The unknown seals were prorated, based on spatial/temporal patterns of bycatch of harbor seals, gray seals, harp seals, and hooded seals. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 1994-1998-1999 was 398-242 harp seals (CV=0.26-0.20). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996). The bycatch occurred principally in winter (January-May) and was mainly in waters between Cape Ann and New Hampshire. One observed winter mortality was in waters south of Cape Cod.

Mid-Atlantic Coastal Gillnet:

Observer coverage of the USA Atlantic coastal gillnet fishery was initiated by the NEFSC Sea Sampling program in July, 1993; and from July to December 1993, 20 trips were observed. During 1994 and 1995 221 and 382 trips were observed, respectively. This fishery, which extends from North Carolina to New York, is actually a combination of small vessel fisheries that target a variety of fish species, some of which operate right off the beach. The number of vessels in this fishery is unknown, because records which are held by both state and federal agencies have not been centralized and standardized. Observer coverage, expressed as percent of tons of fish landed, was 5%, 4%, and 3%, and 5%, and 2% for 1995, 1996, and 1997, and 1998, and 1999, respectively (Table 2).

No harp seals were taken in observed trips during 1993-1997, and 1999. One harp seal was observed taken in 1998 (Table 2). Observed effort was concentrated off NJ and scattered between DE and NC from 1 to 50 miles off the beach. All bycatches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 0 in 1995-1997 (0), and 17 in 1998 (1.02), and 0 in 1999 (0). Average annual estimated fishery-related mortality attributable to this fishery during 1995-1998-1999 was 4-33.0 harp seals (CV=1.02-1.02)

CANADA

An unknown number of harp seals have been taken in Newfoundland and Labrador groundfish gillnets (Read 1994). Harp seals are being taken in Canadian lumpfish and groundfish gillnets, and trawls, but estimates of total removals have not been calculated to date (Anon. 1994). A recent analysis of bycatch in the Newfoundland lumpfish fishery indicates that fewer than 10,000 seals were taken annually from the start of the fishery in 1968 until 1984 (Walsh et al. 2000). Between 1984-1995, annual bycatches have been more variable, ranging between 3,000 and 36,000 animals. Since 1996, bycatches have varied between 16,000 and 23,000 seals annually (DFO 2000).

There were 3,121 cod traps operating in Newfoundland and Labrador during 1979, and about 7,500 in 1980 (Read 1994). This fishery was closed at the end of 1993 due to collapse of Canadian groundfish resources.

In 1996, observers recorded four harp seals (one released alive) in Spanish deep water trawl fishing on the southern edge of the Grand Bank (NAFO Areas 3) (Lens 1997). Seal bycatches occurred year-round, but interactions were highest during April-June. Many of the seals that died during fishing activities were unidentified. The proportion of sets with mortality (all seals) was 2.7 per 1,000 hauls (0.003).

Table 2. Summary of the incidental mortality of harp seal (*Phoca groenlandica*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type ¹	Observer Coverage ²	Observed Mortality ³	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Northeast Multispecies Sink Gillnet	94-98 95-99	301	Obs. Data Weighout, Logbooks	.07, .05, .04, .06, .05, .06	33, 27, 9, 40, 4, 4	861, 694, 89, 269, 78, 81	.58, .27, .55, .50, .48, .78	398- (0.26) 242 (.20)
Mid Atlantic Coastal Sink Gillnet	95-98 99	Unk ⁴	Obs. Data Weighout	.05, .04, .03, .05, .02	0, 0, 0, 1, 0	0, 0, 0, 17, 0	0, 0, 0, 1.02, 0	4- (1.02) 3 (1.02)
TOTAL								402- (0.26) 245 (.20)

¹ Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects ~~Weighout~~ landings data (Weighout), and total landings are used as a measure of total effort for the sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of ~~some~~ fishing effort in the Northeast multispecies sink gillnet fishery.

² The observer coverage for the Northeast multispecies sink gillnet fishery is measured in trips. Observer coverage for the Mid Atlantic coastal sink gillnet fishery is measured in tons of fish landed.

³ In the New England sink gillnet fishery thirty-one and zero harp seals were taken on pingered trips during 1997 and 1998, respectively. During 1997, 1998 ~~and 1999 there were 31, thirty-one, 4 and four~~ harp seals ~~were~~ observed on "mammal trips", respectively. See Bisack (1997) for "trip" type definitions. ~~During 1999 two harp seals were observed on "fish trips" and three were observed taken from pingered nets.~~

⁴ Number of vessels is not known.

Other Mortality

Harp seals have been commercially hunted since the mid-1800's in the Canadian Atlantic (Stenson 1993). A total allowable catch (TAC) of 200,000 harp seals was set for the large vessel hunt in 1971. The TAC varied until 1982 when it was set at 186,000 seals, and remained at this level through 1995 (Stenson 1993; Anon 1998). The TAC was increased to 250,000 and 275,000, respectively in 1996 and 1997 (Anon 1998). Catches ranged from 124,000 to 231,000 from 1971-1982, declining to a range of 19,000 to 94,000 between 1983-1995, and increased dramatically to 242,000 (1996) and 261,000 (1997) (Stenson 1993; Anon 1998). ~~Harp seals are also hunted in the Canadian Arctic and in Greenland (DFO 2000). There are no recent statistics for the Canadian Arctic, but during the late 1970's annual catches ranged between 1,200 and 6,500 animals. Prior to 1980, Greenland catches were less than 20,000 annually, but in recent years have dramatically increased to around 100,000 (DFO 2000).~~ The commercial catches do not account for subsistence takes, and animals that are killed but not landed (struck and lost) (Lavine 1999). ~~A recent analysis of the struck and loss rates suggests that the rate for young seals (majority of Canadian take) is less than 5%, while losses of older seals is higher (approximately 50%) (DFO 2000).~~

From 1988-1993 strandings each year were under 50, approaching 100 animals in 1994, and exceeding 100 animals in 1995-1996 (Rubinstein 1994; B. Rubinstein, New England Aquarium, pers. comm.). In addition, in 1996 there was a stranding in North Carolina. From 1997-1998 224 strandings were recorded, including one in North

Carolina. Most of the strandings occurred in Maine (27), Massachusetts (51), New Jersey (21), and New York (92). Few animals showed signs of human interactions, and except for one shot animal the interactions were classified as other. The increased number of strandings may indicate a possible shift in distribution or expansion southward into USA waters.

STATUS OF STOCK

The status of the harp seal stock, relative to OSP, in the USA Atlantic EEZ is unknown, but the population appears to be increasing in Canadian waters. The species is not listed as threatened or endangered under the Endangered Species Act. The total fishery-related mortality and serious injury for this stock is believed to be very low relative to the population size in Canadian waters and can be considered insignificant and approaching zero mortality and serious injury rate. The level of human-caused mortality and serious injury in the USA Atlantic EEZ is unknown, but believed to be very low relative to the total stock size; therefore, this is not a strategic stock.

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